Marine Human Health Risk Assessment

Off Shore Areas of the Former Robert E. Derecktor Shipyard

Naval Education and Training Center Newport, Rhode Island

Northern Division Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0302

September 1998

TETRA TECH NUS, INC.

MARINE HUMAN HEALTH RISK ASSESSMENT
OFF-SHORE AREAS OF THE FORMER ROBERT E. DERECKTOR SHIPYARD
NETC-Newport, Rhode Island

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September 29, 1998

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Project Number N7752

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Reference: CLEAN Contract No. N62472-90-D-1298
Contract Task Order No. 0302

Subject: Submittal of the Final Human Health Risk Assessment, Derecktor Shipyard (Off-Shore)

Dear Mr. Shafer:

Enclosed you will find four copies of the Final Human Health Risk Assessment for the Off-Shore Areas of the Former Robert E. Derecktor Shipyard. This report has been prepared as a revision of the draft final dated June 1998, amended as stated in our responses to comments issued September 9, 1998.

While modifications were made in accordance with the responses to the comments, overall conclusions for the study have not changed through these revisions.

If you have any questions regarding this material, please do not hesitate to contact me.

Very truly yours,

Stephen S. Parker
Project Manager

SSP/rt

Attachment

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File N7752-3.2 (w/o encl.)

bc: G. Maynard (w/encl. - 1)
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MARINE HUMAN HEALTH RISK ASSESSMENT

OFF SHORE AREAS OF
THE FORMER ROBERT E. DERECKTOR SHIPYARD

NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION - NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 1812BJH
Naval Facilities Engineering Command
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Contract Number N62472-90-D-1298
"CLEAN" Contract Task Order 0302

September 1998

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION PAGE

APPENDICES

TABLE OF CONTENTS (Continued)

TABLES

TABLE OF CONTENTS (Continued)

FIGURES

LIST OF ACRONYMS

AAL	Rhode Island Ambient Air Limit
ACOE	U.S. Army Corps of Engineers
ARAR	Applicable or Relevant and Appropriate Requirement
AVS	Acid Volatile Sulfides
AWQC	Ambient Water Quality Criteria
B&RE	Brown & Root Environmental
CAD	Contained Aquatic Disposal
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of Concern
CT	Central Tendency
DAF	Dissolved Air Flotation
EPA	U.S. Environmental Protection Agency
ERA	Marine Ecological Risk Assessment
ER-L	Effects Range-Low: NOAA Adverse Effects Benchmark Value For Sediment
ER-M	Effects Range-Median: NOAA Adverse Effects Benchmark Value For Sediment
FFA	Federal Facilities Interagency Agreement
FS	Feasibility Study
FWENC	Foster Wheeler Environmental Corporation
GRA	General Response Action
HHRA	Human Health Risk Assessment
HI	Hazard Index Ratio
IAS	Initial Assessment Study
IEUBK	Integrated Exposure and Uptake Biokinetic Model
IRP	Installation Restoration Program
IU/BK	Integrated Uptake/Biokinetic Model
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/l	milligram per liter
MLW	Mean Low Water Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

LIST OF ACRONYMS (Continued)

NETC	Naval Education and Training Center
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NORTHDIV	Northern Division
NPL	National Priorities List
NS	Nearshore
O&M	Operation and Maintenance
OS	Offshore
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PDI	Pre-Design Investigation
POTW	Publicly-Owned Treatment Works
PPE	Personnel Protective Equipment
PRG	Preliminary Remedial Goal
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	Risk Reference Dose
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SAIC	Science Applications International Corporation
SARA	Superfund Amendment and Reauthorization Act
SEM	Simultaneously Extracted Metals
SER	Shore Establishment Realignment Program
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List

LIST OF ACRONYMS (Continued)

TBC	To Be Considered Guidance
TCL	Target Compound List
TCLP	Toxic Characteristic Leaching Procedure
TCR	Tissue Concentration Ratio
TEV-HQ	Threshold Effects Value - Hazard Quotient
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRC	TRC Environmental Corporation
TSDF	Treatment, Storage, and Disposal Facility
TSS	Total Suspended Solids
TWA	Time-Weighted Average Concentration
µg/dl	microgram per deciliter
µg/kg	microgram per kilogram
µg/l	microgram per liter
URI	University of Rhode Island
VOC	Volatile Organic Compound

E.O EXECUTIVE SUMMARY

This report has been prepared to describe risks to humans that are estimated from the contaminants present in the shellfish and (to a limited degree) sediments within Coddington Cove. This study is a part of an extended investigation of the former Robert E. Derecktor Shipyards of Rhode Island Inc. which formerly leased property on the shoreline in this area from the Navy through the Rhode Island Port Authority. This study was performed under the NETC Installation Restoration Program, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

This risk assessment follows a six step process for assessment of risks as prescribed by the EPA. These steps, and the findings of each are briefly described in the following paragraphs.

In the first step, Hazard Identification, all chemical constituents detected in the shellfish and sediment were identified as potential contaminants of concern. The data used was collected from Coddington Cove in 1995 and 1996 by the University of Rhode Island and SAIC for the purposes of performing an ecological risk assessment. The data set included analysis of indigenous blue mussels, two species of hard clams (cherrystones and quahogs), and lobsters.

The second step, Fate and Transport, documents the chemical and physical parameters that apply to the potential contaminants of concern, and identifies their likelihood to remain in their present form in the media noted. The possibility that many of these contaminants may be derived from other sources than the Derecktor Site was identified, and it was noted that most chemical constituents identified are in a stable state in the media sampled.

In the third step, the Dose-Response Assessment, the documented toxicity of each of the potential contaminants of concern are identified.

The fourth step is the Exposure Assessment, in which the persons likely to contact the contaminated shellfish and sediment are identified. For this report, recreational fishermen and their children were considered likely to ingest shellfish from this area, and subsistence fishermen were also likely to ingest shellfish from this area. In addition, trespassers (adults and children) who might swim or wade at a gravel beach area to the south of the site were deemed likely to

contact sediments containing elevated levels of contaminants that may wash into this beach area from an area 500 feet north of the site.

Also as a part of the exposure assessment, the concentrations of the chemical constituents found, or "dose", that persons might ingest are estimated. One of the primary efforts of this estimation it to determine how much shellfish is ingested by the recreational and subsistence fishermen. The rates selected were as follows: 150 grams (or 5.3 ounces) of shellfish would be ingested by an adult recreational fisherman 2.9 times per year. For children, 48 grams, or 1.7 ounces would be ingested the same number of times per year. For subsistence fishermen, 150 grams (or 5.3 ounces) of shellfish would be ingested 37 times per year. These rates are based on an assessment of available literature, and do not necessarily reflect the most conservative of the values suggested by some literature sources. However, they are somewhat conservative, considering the limited availability of shellfish at the area, the industrial nature of the area, the large ship traffic, and the availability of more productive areas in Narragansett Bay.

In the fifth step, Risk Characterization, "Dose" for each exposure is compared with toxicity criteria, and a quantified risk is estimated. Estimated cancer risk is presented in scientific notation such that an Incremental cancer risk increases of 1E-4 means there is an excess incremental lifetime cancer risk of one in ten thousand from exposure to that contaminant under the exposure route identified. In general, cancer risks of 1E-4 (one in ten thousand) or above are considered unacceptable, cancer risk increases between 1E-6 (one in one million) and 1E-4 are identified for consideration, and cancer risk increases of 1E-6 or below are considered negligible. Similarly, Non-cancer risks are presented as quotients, where a value of 1.0 or greater indicates possibility for the non-cancer health effect to occur.

The findings of the risk characterization for one off shore areas of the Former Derecktor Shipyard were that arsenic content of the shellfish presents the highest cancer risk, with PCBs and some fuel-derived contaminants (PAHs) also contributing. Increased cancer risk was primarily presented to the subsistence fishermen assumed to utilize the area, predictably due to the estimated volume of shellfish ingested. Non cancer risks were slightly increased for the subsistence fisherman also, from arsenic only. There was only a slight increased risk notable for the trespasser, despite the use of sediment data from one of the stations with the highest concentrations of chemical constituents.

The final step is an Uncertainty Analysis, in which the assumptions that are used are reviewed in light of the findings. The primary uncertainties noted in this analysis are the validity of risk calculated for arsenic in shellfish, and the likelihood of the shellfish to be taken from this area at the rates estimated.

The toxicity value used for arsenic is derived from an inorganic form of arsenic in drinking water (arsenic trioxide). It has been documented that 80-90% of arsenic in shellfish tissue is in the organic form which is not toxic. In addition, arsenic concentrations have been noted to be elevated in the soils at Aquidneck island, due to the mineral content of the bedrock. This leads us to believe that the arsenic is not a site-specific contaminant. Notably, the arsenic concentrations measured in (for instance) mussels were between 2.68-12.56 mg/kg at the site (average = 7.25 mg/kg), whereas arsenic in mussels collected at control stations at castle hill cove and Jamestown were measured at 4.7-6.8 mg/kg (average of 5.7 mg/kg).

The use of the study area for shellfish collection by recreational or subsistence fishermen is also in question. The rates used were those that are stated by the Narragansett Bay Project (n.d.) briefing paper on the "Health Risk From Chemically Contaminated Seafood", but are three times higher than the national rates for recreational fishermen and 30 times higher than the national rates for subsistence fishermen published by the EPA. It is recognized that the residents of Rhode Island may eat more shellfish than the national average, thus these rates were used, despite the industrial nature of the property.

Finally, it should be noted that citizens have reported that recreational divers regularly take lobsters from the north of the site, accessed by the breakwater that bounds the north side of Coddington Cove, although it is not known on which side these people dive. This may lead the reader to the conclusion that the recreational collection of lobsters from this area might carry the most significant weight of all the scenarios evaluated in this study.

The risks calculated and reported in this risk assessment will be used in conjunction with the risks estimated for ecological receptors to calculate cleanup criteria for the marine environment near the former Derecktor Shipyard.

1.0 INTRODUCTION

This report presents the human health risk assessment (HHRA) for the offshore areas of the former Robert E. Derecktor Shipyard, located at the Naval Education and Training Center (NETC) in Newport, Rhode Island.

Field investigations were performed for the Navy by Science Applications International Corporation (SAIC) and the University of Rhode Island (URI), under contract to B&R Environmental in 1995 and 1996. During these investigations, marine sediments and biota were sampled to obtain data used to assess potential ecological impacts. The results were presented in the Marine Ecological Risk Assessment Report (SAIC, URI; May 1997). Information from biota sampling was used to assess potential human health exposure risks for scenarios that were discussed with EPA and RIDEM.

The primary objectives of the HHRA are to identify the constituents of potential concern (COPCs) in the environmental media, characterize the potential pathways for exposure, and estimate the potential for adverse human health effects for the identified COPCs and exposure conditions.

Specific exposure scenarios are considered and developed that represent current and/or future anticipated situations in which people may be exposed to site-related constituents. Efficacy of specific remedial programs is not included as part of this analysis.

Human health risks associated with the site are presented with regard to potential effects from the identified COPCs. These potential effects include an increased risk of cancer or the occurrence of non-cancer (systemic) effects. The assessment of risks associated with exposures to carcinogens involves calculations of the incremental lifetime probabilities of cancer that take into account the exposure estimates and the carcinogenic potencies (i.e., slope factors) for the constituents. For determining whether non-cancer health effects may be a concern, constituent-specific hazard quotients (HQs) are used which incorporate the exposure estimates and acceptable exposure levels (i.e., reference doses (RfDs)) for the constituents.

Ultimately, the HHRA presented in this report is expected to be used within a risk management framework in making decisions concerning what actions, if any, should be taken at this site (including, for example, the collection of additional data or implementation of a remedial program).

The results of the HHRA should be used in concert with other information gathered for the site. The HHRA will identify whether the current or anticipated future land use conditions present unacceptable risks. The results of the HHRA will also identify constituents and exposure pathways contributing the greatest risk to the receptor populations. From this information, recommendations for future activities at the site (including remedial alternatives) can be made such that public health is protected.

The HHRA methodology is structured utilizing the most current methods as described in EPA Region I Supplemental Risk Assessment Guidance for the Superfund Program, Part 1 - Guidance for Public Health Risk Assessments (1989a) and EPA's Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A) (1989b). Where assumptions are made, they are realistic but conservative, i.e., protective of public health. In keeping with accepted practices for conducting such assessments, all assumptions are carefully discussed and an assessment made of the uncertainty associated with the overall health risk estimates.

Following the guidelines accepted by the EPA, the basic components of the HHRA are organized and presented for this site as follows:

- Hazard Identification (Section 2.0);
- Contaminant Fate and Transport (Section 3.0);
- Dose-Response Assessment (Section 4.0);
- Exposure Assessment (Section 5.0);
- Risk Characterization (Section 6.0); and
- Uncertainty Assessment (Section 7.0).

Reference information and calculation spreadsheets are presented in appendices as appropriate.

2.0 HAZARD IDENTIFICATION

This section of the HHRA provides a facility/site description and history of the former Robert E. Derecktor Shipyard (DSY) offshore areas, an overview of the data collection performed in conjunction with the off-shore investigations, an evaluation of these data for purposes of the HHRA, and the selection of medium-specific chemicals of potential concern (COPCs). COPCs are selected only for the media likely to be contacted by people under the current and/or future anticipated land uses at the site (as identified in Section 5.0).

2.1 FACILITY/SITE DESCRIPTION

The NETC facility is comprised of approximately 1,063 acres, with portions of the facility located in Newport, Middletown, and Portsmouth, Rhode Island. The facility is approximately 60 miles southwest of Boston and 25 miles south of Providence. The facility layout is long and narrow, following the shoreline of Aquidneck Island for nearly 6 miles bordering Narragansett Bay. A facility location map is provided on Figure 2-1.

The NETC facility area has been used by the U.S. Navy since the era of the Civil War. Military activities at the base significantly increased during times of war. During World Wars I and II, servicemen were housed on the base. In subsequent peacetime years, on-site facilities were slowly disestablished, until the headquarters of the Commander Cruiser-Destroyer Force Atlantic was located there in 1962. In April 1973, the Shore Establishment Realignment Program (SER) reorganized naval forces and resulted in the disestablishment of several on-site facilities and associated reductions in Navy personnel. Subsequent to this "downsizing", the Navy excessed a significant portion of its original acreage. Other portions of the facility were leased by the Navy to the State of Rhode Island and Economic Development Corporation. Some of these areas, including the on-shore portions of this site were subleased to private enterprises.

A description of the facility, its setting, and surroundings are provided in the Study Area Screening Evaluation Report (SASE) (Draft Final, B&R Environmental, June 1997). The site is designated as off-shore areas (specifically Coddington Cove) near the former Robert E. Derecktor Shipyard. The Ecological Risk Assessment (ERA) Report (Final, SAIC and URI-GSO May 1997) characterizes the

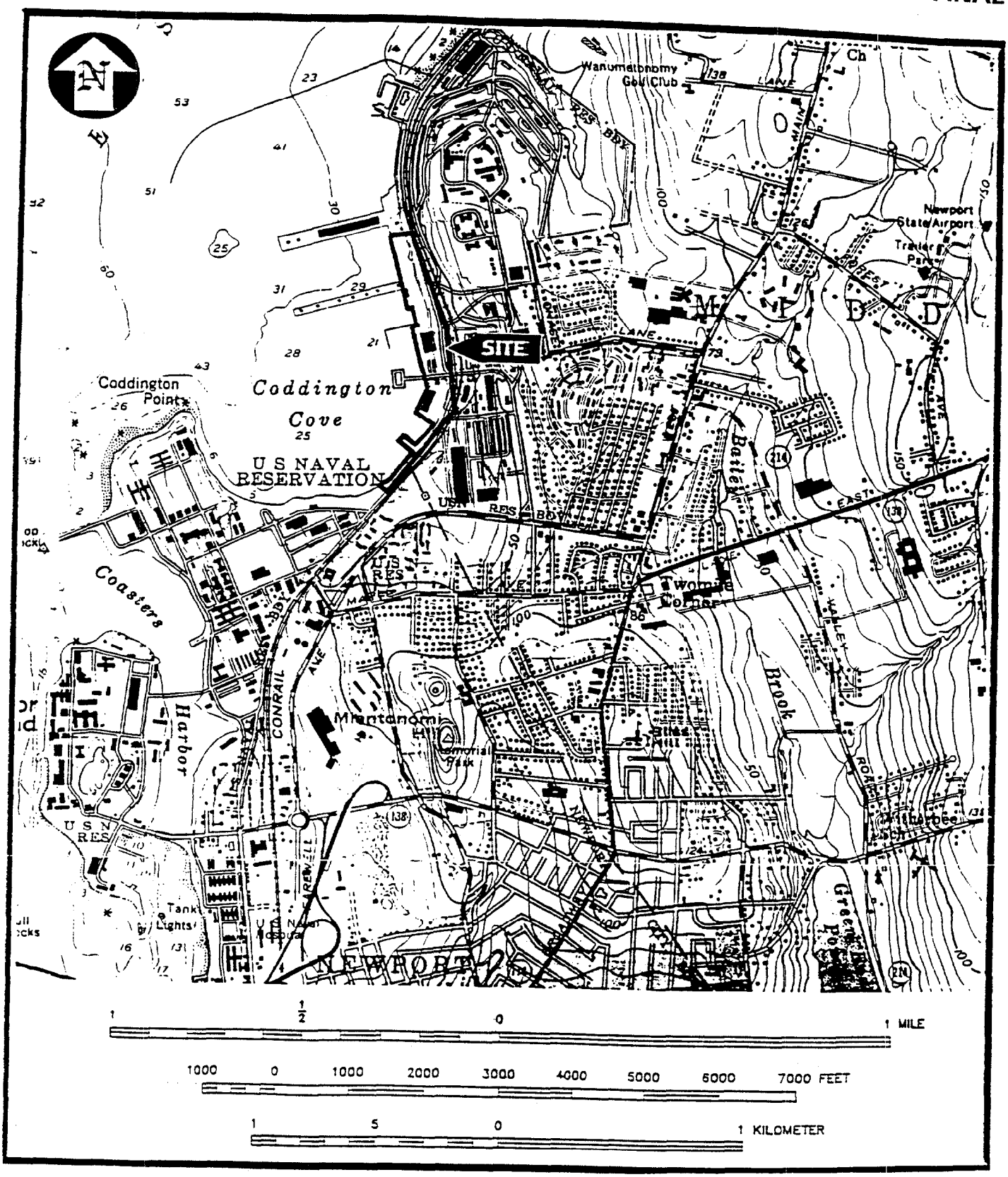

FIGURE 2-1

Site Location Map, Former Robert E. Derecktor Shipyard

off-shore conditions, including suitability of habitat and extent of aquatic vegetation, diversity, and abundance of shellfish.

These prior reports were evaluated to determine the media that should be addressed by the HHRA for the marine environment at the site. To summarize, the site is best characterized as an industrial port with deep water pier space along the waterfront. The water depths within the area where the samples were collected are between 20 and 50 feet. This precludes the potential for human exposure to contaminants in sediments at and near these stations. However, Coddington Cove is not restricted from boating traffic. Therefore, it is appropriate to evaluate the exposure of contaminants to humans through ingestion of shellfish taken recreationally or by subsistence fishermen. It should be noted that there is a state-imposed ban on shellfish collections within Coddington Cove. This ban is imposed for collection of bivalves (oysters, clams mussels, etc.) but not for lobster. It has been reported that recreational scuba divers take lobster from the area near the breakwater bounding the north side of Coddington Cove.

The shellfish ban is set for Coddington Cove because of the proximity of the site to the Newport sewage treatment plant outfall. However, this plant is designed to address fecal matter only, and is not meant to treat chemicals received by industrial users. The RIDEM has set the ban because it has been determined through tidal modeling that chemical discharges through the outfall or a failure or overflow condition at the Newport treatment plant would affect shellfish in this area (U.S. Navy, 1997a). In addition, RIDEM indicated that the area is recognized as an area not conducive to shellfishing because of the presence of large ship traffic (U.S. Navy, 1997b), implying that a productive area is not being lost by this closure.

Shellfishing at the site will remain restricted as long as the treatment plant and outfall are in operation (U.S. Navy, 1997a). If tertiary treatment is added at the Newport POTW, or if the outfall is moved, the area could be re-opened for shellfishing. The actual amounts of shellfish that this area could regularly yield to recreational or subsistence fishermen is unknown. Further discussion on this topic is presented in Section 5 of this report.

One of the goals of risk assessment under CERCLA is to provide a conservative estimate of risk. To do this it should be assumed that some persons, particularly subsistence fishermen, will take shellfish from areas where a ban is imposed. In addition, if the Newport POTW were upgraded to

include tertiary treatment or the outfall moved further off shore, the area could be reopened. For these reasons, the exposure to shellfish ingestion is evaluated in this risk assessment.

Due to the depth of water within most of the study area, there is little likelihood of human contact to the sediments. However, there is a beach area to the south of the site where piles of soil were recently removed. This area is a gravely and stony beach that has a very gradual grade to the off shore areas. It is currently fenced and although it is not posted, swimming, wading, and shellfishing in this area is prohibited by the NETC police department, who patrols this area regularly.

The proximity of the beach to the site is such that the area could have been impacted by site activities, although soil samples collected in the upland side of the beach indicated no elevated concentrations of site-related contaminants, and sediment samples from the off-shore area to the south of the beach also indicated no elevated concentrations of site related contaminants. However, because of the proximity of the beach to the site, a cursory, yet conservative, examination of this route of exposure has been evaluated in this report.

2.2 DATA COLLECTION

Shellfish tissue data were collected from the following organisms: indigenous blue mussel (*Mytilus edulis*), deployed mussel (*Mytilus edulis*), hard shell clams (*Mercenaria mercenaria and Pitar morrhuana*), lobster (*Homarus americanus*), cunner fish (*Tautogolabrus adsperus*), and mummichog fish (*Fundulus heteroclitus*).

The cunner fish and the mummichog fish are considered inedible for human consumption and will not be evaluated in the HHRA. Additionally, the deployed mussels were brought to the site from an unaffected area, and suspended in the water column for a test period days to provide an indication of the uptake of chemicals present and the effects of those chemicals on the organisms themselves. The indigenous blue mussels present in sediment are expected to be more representative of shellfish collected by the human receptor so deployed mussels will also not be evaluated in this HHRA. Appendix D provides a summary of indigenous blue mussel data in comparison to deployed blue mussel data.

The hepatopancreas ("Tamale" or liver) was not included under the lobster ingestion exposure pathway. The analytical laboratory (URI GSO) cited difficulty with analytical procedures with a material that is so high in lipid content. The fact that this organ tends to accumulate toxins might underestimate the carcinogenic and noncarcinogenic risks for the lobster ingestion exposure pathway. However, the hepatopancreas is also small in size compared with the rest of the edible lobster tissue, therefore, the exposure to the chemicals in this organ is expected to be lower than the rest of the lobster tissue consumed. An additional uncertainty exists for hepatopancreas exposure regarding the number of individuals who would be expected to consume this organ (expected to be less than 100% of individuals exposed).

Figures 2-2 through 2-4 present shellfish collection stations.

Sediment samples were collected at all stations identified in Figures 2-2 through 2-4. However, only one station was deemed viable for consideration for human exposure through a trespasser scenario. Sediment data for this scenario was collected from the surface of sediment (0-18 cm) at station 29 (DSY-29). A description of collection/analytical methodologies are provided in the Final Marine Ecological Risk Assessment for Derecktor Shipyard; (URC/SAIC, May, 1997).

2.3 DATA EVALUATION

The steps outlined below were performed to organize the data validated by SAIC for the Ecological Risk Assessment into a form manageable and appropriate for the baseline HHRA. The steps described below were conducted as part of the HHRA and are consistent with current EPA (1989b, 1992b) and EPA Region I (1989a) guidance.

1) Sort all shellfish tissue data and decide on edibility of tissue samples collected for human receptors and/or sort the sediment data per location.
2) Evaluate methods of analysis.
3) Evaluate the data qualifiers and codes.
4) Evaluate blank data (conducted during the data validation performed prior to HHRA for all media except soil gas, sediment, and shellfish).
5) Evaluate duplicate data.
6) Evaluate the sample quantitation limits (SQLs).
7) Develop data sets by medium.

8) Develop a set of COPCs from the entire data set for each medium of interest at the site.

Note: Data was originally reported by the laboratory in dryweight units. For this report, data was converted to wet weight by using moisture content recorded by the laboratory. All analytical data presented in this report is presented as wet weight concentration.

2.3.1 Shellfish

Briefly, the general methods used for organizing and evaluating the shellfish tissue data used for the HHRA, which correlate with the previously described steps, include the following:

1) All analytical data were initially sorted by media and edibility for human consumption, i.e. sorted by tissue type. Any tissue samples not considered edible (mummichog fish) were removed from inclusion for assessment of human risk. The media identified in Section 5.0 as being relevant and edible with regard to potential future human exposures at the Site include:

- hard shell clam samples (11 total hard shell clam tissue samples were collected)
- blue mussel samples (8 total blue mussel tissue samples were collected)
- lobster samples (9 total lobster muscle tissue samples were collected)

2) The sediment and shellfish samples were analyzed using the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends program analytical methods (NOAA, 1992). Although not CLP methods, these data analyses are also considered acceptable for use in the HHRA. The NOAA methods have been developed specifically for analysis of trace contaminants in sediment and marine tissue. A number of QA/QC procedures were used including, but not limited to, field duplicate samples and laboratory blanks. Since a number of constituents were detected in the blanks, a blank evaluation was performed in the HHRA as described below in step 4).

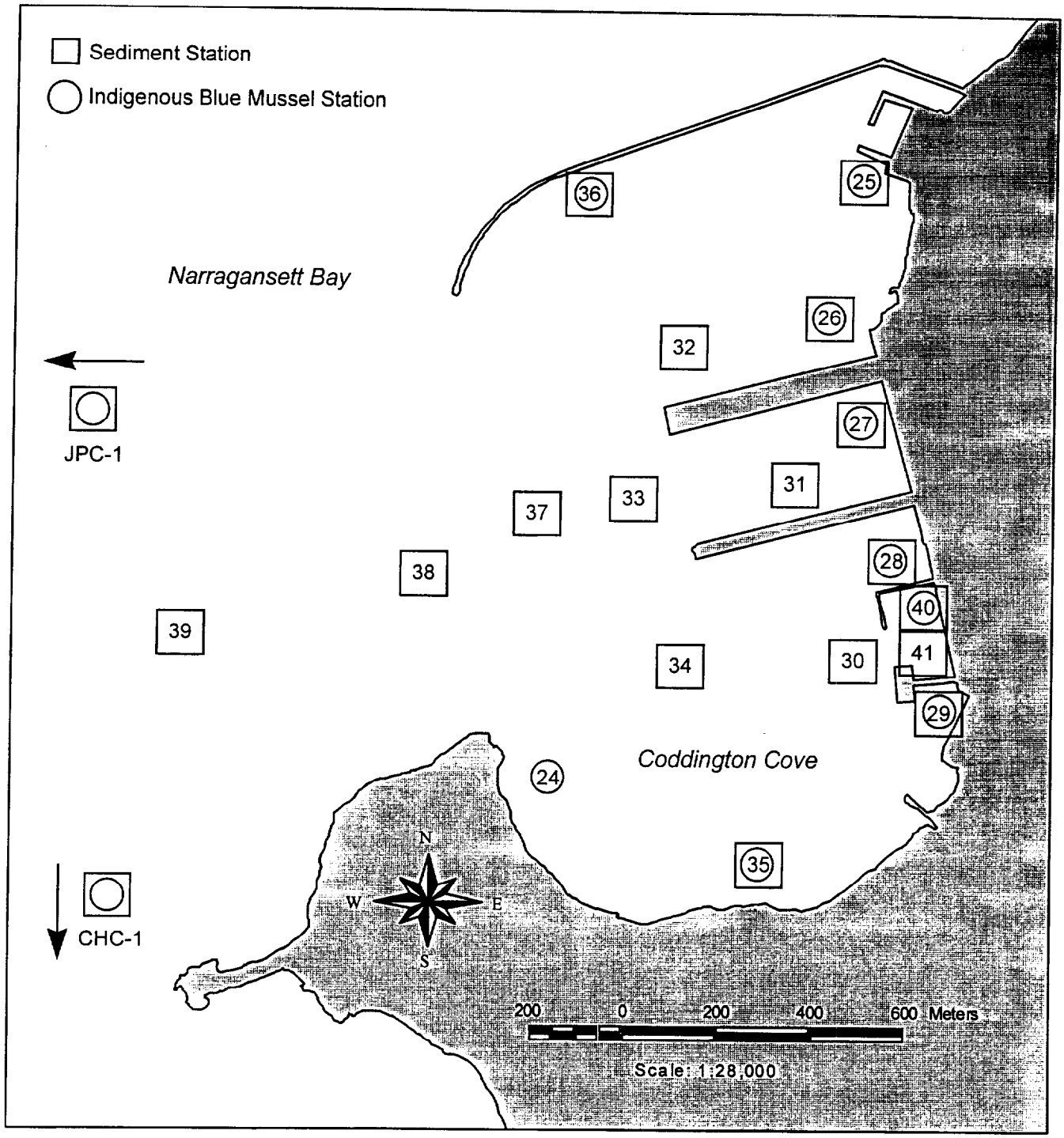

FIGURE 2-2
INDIGENOUS BLUE MUSSEL SAMPLING STATIONS
FORMER DERECKTOR SHIPYARD HHRA
NEWPORT RHODE ISLAND

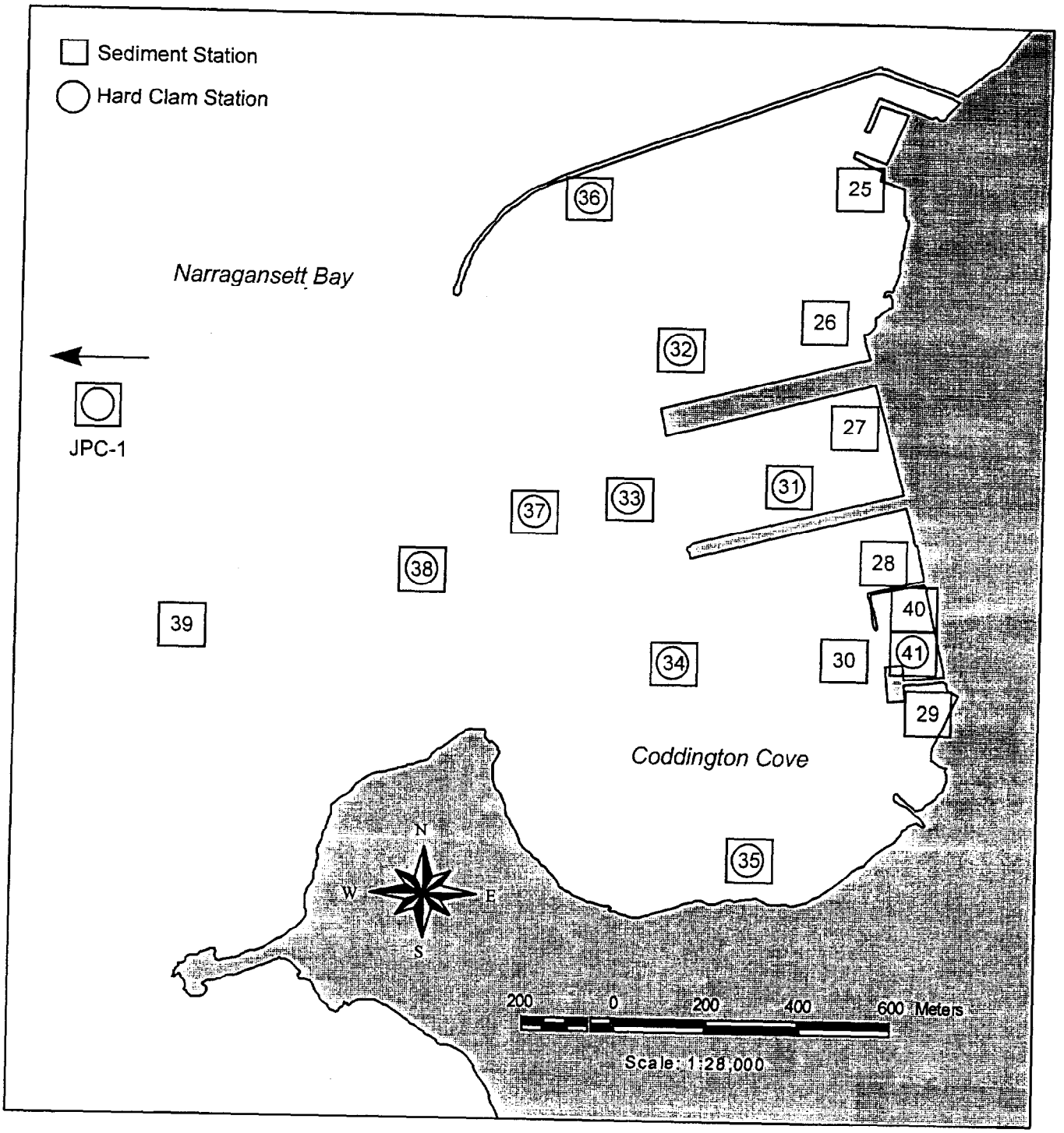

FIGURE 2-3
HARD CLAM SAMPLING STATIONS
FORMER DERECKTOR SHIPYARD HHRA
NEWPORT RHODE ISLAND

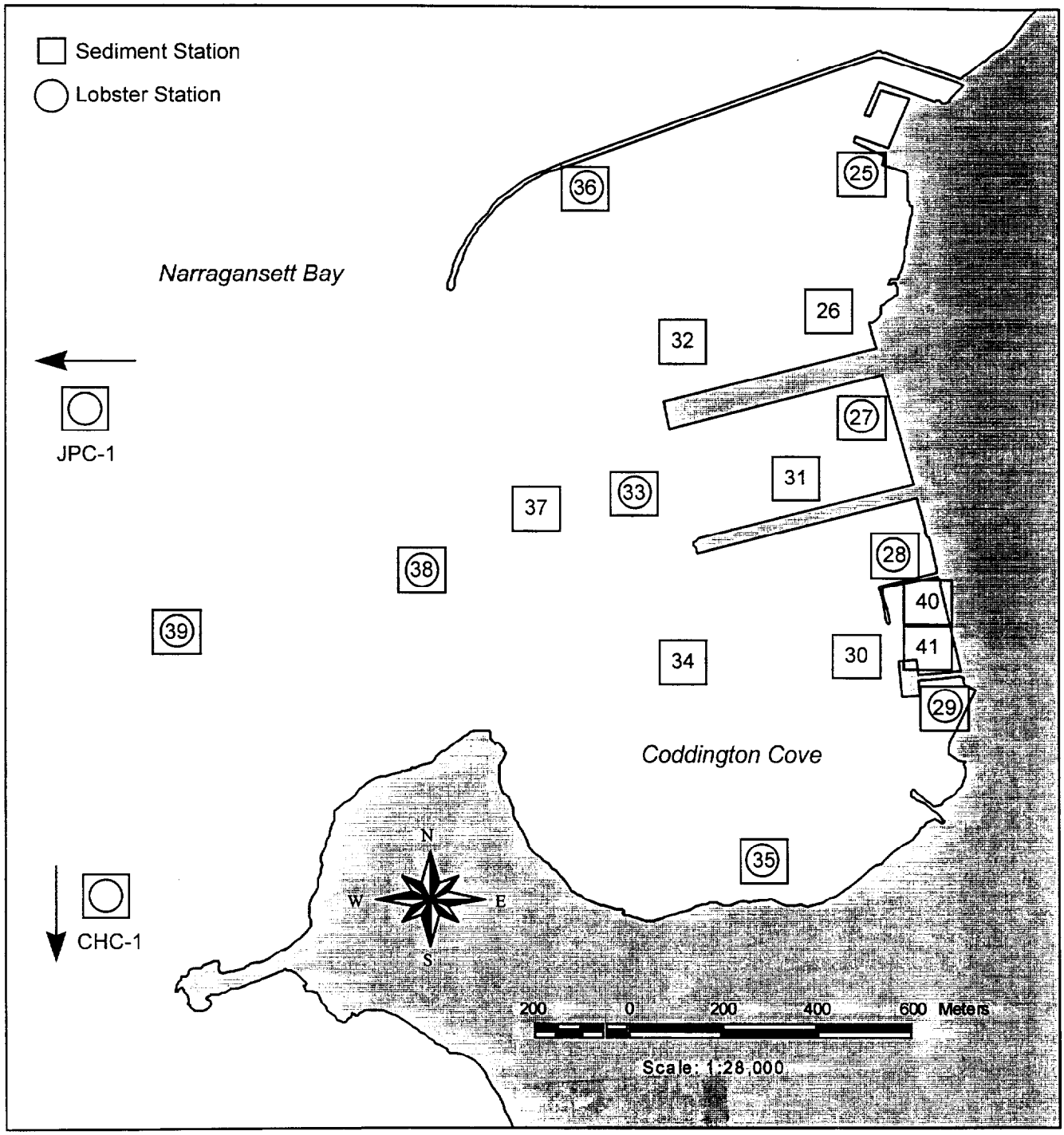

FIGURE 2-4
LOBSTER SAMPLING STATIONS
FORMER DERECKTOR SHIPYARD HHRA
NEWPORT RHODE ISLAND

3) Data validation qualifiers were also assessed during the data evaluation process. As indicated in EPA (1989b, 1992b) and EPA Region I (1989a) guidance, unqualified data and data qualified with a "J" are treated as detectable concentrations. Data qualified with a "UJ" or "U" are treated as non-detectable concentrations. As described in step 7) below, non-detected values are assigned a value equal to the SQL or one-half the SQL. With the exception of data qualified with an "R" or data for constituents not detected in any medium, all data are included in the HHRA. As described by EPA (1989b, 1992b), "J", "U", "UJ", and "R" qualifiers are defined as follows:

"J" - Value is estimated, either for a Tentatively Identified Compound (TIC) or when a constituent is present but the value is less than the contract required quantitation limit (CRQL). Data qualified as estimated may be biased high or low i.e., may overestimate or underestimate the actual concentrations.

"U" - Constituent was analyzed for, but not detected. The non-detected values reported in the data sets correspond to the SQLs.

"UJ" - Constituent was analyzed for, but not detected. The "J" qualifier signifies that the SQL is estimated.

"R" - Quality control assessment indicates the data are unusable and are therefore rejected for use in risk assessments. Both the presence and concentration of the constituent are uncertain.

[Note: EPA (1992b) refers to EPA (1989b) for a continued discussion on the potential use of qualified data in risk assessments.]

4) Field and laboratory blanks are used to segregate actual site contamination from cross contamination from field or laboratory procedures. Blank contamination is an important indicator of false positives, i.e., reported detection of a constituent that is not actually present. As indicated in EPA (1989b, 1992b), sample results are considered positive only if concentrations exceed ten times the concentration of a common laboratory contaminant in a blank, or five times the concentration of a

constituent that is not considered a common laboratory contaminant. If less than five or ten times the blank concentration, the constituent is treated as a non-detected value in that sample and, consistent with EPA Region I guidance (1988b and 1988c), the SQL is assumed to be equal to the sample value that was reported initially.

5) Duplicate samples will be averaged and considered as one result. For duplicates, where one result is positive and the other result is a non-detected value, the problem of calculating an average (arithmetic mean) result arises whenever half the detection limit exceeds the positive result. In these situations, the positive result will be used to represent the non-detected value.

6) Although non-detected values with extremely high SQLs may be removed from data sets (EPA, 1989b), these non-detected values are retained for the purposes of this HHRA based on the bias toward sampling in areas of suspected contamination during the sampling programs. As described by Region I (EPA, 1989a), non-detected values in samples from a biased sampling program have a greater probability of being contaminated than non-detected values from an unbiased program. In calculating exposure point concentrations (EPCs), a value of either the SQL or one-half the SQL is assigned. If a constituent was likely to be present below the SQL, then a value of one-half the SQL is assigned to the non-detected value. A value equal to the SQL is used for constituents likely to be present at concentrations close to or greater than the SQL. An analysis of the data identified only one PCB congener, 18 (22'5), in hard shell clams, which was likely to have a concentration close to or greater than the SQL.

7) Tables 2-1, 2-2, and 2-3 provide summary statistics (frequency and range of detects) for constituents detected in hard shell clams, blue mussels, and lobster tissue.

8) The selection of COPCs is presented in Section 2.5.

2.3.2 Sediment

Briefly, the general methods used for organizing and evaluating the sediment data used for the HHRA, which correlate with the previously described steps, include the following:

1) All analytical data were initially sorted by sampling location. An evaluation of the sediment samples was conducted to determine the sampling location proximal to the area where exposure could occur, with generally the highest hits of constituents found in sediment samples collected from Coddington Cove. This was determined to be sampling location DSY-29-S.
   Data from this station will be used to estimate risks for trespasser receptors exposed to sediments at the gravel beach south of DSY.

2) This step is the same as explained in Section 2.3.1 Step 2.

3) This step is the same as explained in Section 2.3.1 Step 3.

4) This step is the same as explained in Section 2.3.1 Step 4.

5) This step is the same as explained in Section 2.3.1 Step 5. However since only one sediment sample was used to estimate exposure for the recreational exposure scenario, duplicate analysis was not applied.

6) This step is the same as explained in Section 2.3.1 Step 6

7) The detected concentrations of constituents at sediment sampling location DSY-29-S are shown in Table 2-4.

8) The selection of COPCs is presented in Section 2.5.

TABLE 2-1
OCCURENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN HARD CLAMS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

	Site-Related Data (wet weight)					
Substance	Frequency of Detection	Frequency Percentage	Range of Positive Detection Min. - Max.	Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
aluminum	11/11	100.00	3.2158 - 14.162	9.772	Y	DSY-41
arsenic	11/11	100.00	0.3024 - 1.3104	0.945	Y	DSY-31
cadmium	11/11	100.00	0.0826 - 0.126	0.09828	Y	DSY-41
chromium	11/11	100.00	0.2422 - 0.3444	0.2772	Y	DSY-36
copper	11/11	100.00	0.8988 - 2.0132	1.47	Y	DSY-31
iron	11/11	100.00	15.219 - 35.941	23.1	Y	DSY-35
lead	7/11	63.64	0.2251 - 0.4158	0.1862	Y	DSY-37
manganese	11/11	100.00	1.4616 - 2.7902	1.918	Y	DSY-35
mercury	11/11	100.00	0.014 - 0.0235	0.01904	Y	DSY-38
nickel	8/11	72.73	0.217 - 0.5586	0.2296	Y	DSY-31
silver	3/11	27.27	0.091 - 0.1932	0.04186	Y	DSY-32
zinc	11/11	100.00	9.205 - 18.388	14.42	Y	DSY-38
1-methylphenanthrene	9/10	90.00	0.6001 - 22.189	9.52	Y	DSY-33
acenaphthene	4/11	36.36	0.3959 - 0.9146	0.3906	Y	DSY-41
acenaphthylene	4/11	36.36	0.6386 - 1.8926	0.5362	Y	DSY-32
anthracene	10/11	90.91	0.9245 - 4.25	2.324	Y	DSY-31
benz(a)anthracene	10/10	100.00	2.2008 - 18.603	7.56	Y	DSY-31
benzo(a)pyrene	11/11	100.00	0.976 - 6.2989	3.304	Y	DSY-31
benzo(b,j,k)fluoranthene	11/11	100.00	1.2841 - 18.035	7.112	Y	DSY-31
benzo(e)pyrene	5/11	45.45	0.2533 - 1.1477	0.4004	Y	DSY-37
benzo(g,h,i)perylene	8/11	72.73	0.5199 - 4.7911	1.834	Y	DSY-32
chrysene	10/10	100.00	0.9542 - 9.4318	5.04	Y	DSY-31
hexachlorobenzene	9/9	100.00	0.021 - 0.3952	0.11466	Y	DSY-36
fluoranthene	11/11	100.00	6.0897 - 25.005	12.334	Y	DSY-31
fluorene	7/11	63.64	0.4051 - 1.1132	0.4984	Y	DSY-41
high molecular weight pahs	11/11	100.00	15.828 - 87.008	39.76	Y	DSY-31
indeno(1,2,3-cd)pyrene	6/11	54.55	1.1052 - 3.7617	1.1186	Y	DSY-32
low molecular weight pahs	11/11	100.00	6.3029 - 11.968	8.652	Y	DSY-32
perylene	10/10	100.00	0.5474 - 3.5859	1.68	Y	DSY-37
phenanthrene	11/11	100.00	1.287 - 4.9197	3.136	Y	DSY-34
pyrene	11/11	100.00	4.9773 - 27.601	12.642	Y	DSY-31
PCB 101 (2 2'3 5 5')	10/10	100.00	0.7463 - 3.0289	1.834	Y	DSY-31
PCB 105 (2 3 3'4 4')	8/10	80.00	0.2719 - 34.22	4.564	Y	DSY-31
PCB 118 (2 3'4 4'5)	10/10	100.00	0.5583 - 2.5811	1.582	Y	DSY-31
PCB 128 (2 2'3 3'4 4')	10/10	100.00	0.1376 - 0.9156	0.518	Y	DSY-35
PCB 138 (2 2'3 4 4'5)	10/10	100.00	1.1096 - 6.6214	4.004	Y	DSY-36
PCB 153 (2 2'4 4'5 5')	10/10	100.00	2.398 - 7.8647	5.572	Y	DSY-37
PCB 170 (2 2'3 3'4 4'5)	10/10	100.00	0.6114 - 1.5689	0.9282	Y	DSY-41
PCB 18 (2 2'5)	4/10	40.00	0.1409 - 0.4216	0.3906	Y	DSY-36
PCB 180 (2 2'3 4 4'5 5')	10/10	100.00	1.5853 - 3.6634	2.492	Y	DSY-37
PCB 187 (2 2'3 4'5 5'6)	10/10	100.00	0.9337 - 2.8721	2.03	Y	DSY-37
PCB 195 (2 2'3 3'4 4'5 6)	10/10	100.00	0.1444 - 0.5673	0.3052	Y	DSY-33
PCB 206 (2 2'3 3'4 4'5 5'6	10/10	100.00	0.5828 - 1.1311	0.8316	Y	DSY-36
PCB 209 (2 2'3 3'4 4'5 5'6	10/10	100.00	0.2679 - 1.3805	0.7266	Y	DSY-36

TABLE 2-1
OCCURENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN HARD CLAMS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Site-Related Data (wet weight)					
	Frequency of Detection	Frequency Percentage	Range of Positive Detection Min. - Max.	Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
PCB 28 (2 4 4')	10/10	100.00	0.0372 - 3.3723	1.2684	Y	DSY-34
PCB 44 (2 2'3 5')	9/10	90.00	0.0899 - 1.6501	0.4774	Y	DSY-33
PCB 52 (2 2'5 5)	10/10	100.00	0.3614 - 1.6262	0.8638	Y	DSY-35
PCB 66 (2 3'4 4')	10/10	100.00	0.8905 - 3.1249	1.652	Y	DSY-36
pcb sum of congeners	10/10	100.00	11.155 - 66.536	29.68	Y	DSY-31
pcb sum of congeners x 2	10/10	100.00	22.309 - 133.07	59.36	Y	DSY-31
mirex	8/8	100.00	0.0276 - 0.1488	0.08092	Y	DSY-32
o,p'-DDE	5/10	50.00	0.1558 - 0.5363	0.168	Y	DSY-31
p,p'-DDE	10/10	100.00	0.2129 - 0.6649	0.413	Y	DSY-35
tributyltin	6/6	100.00	4.2854 - 9.3996	6.482	Y	DSY-36

Notes:
Units are mg/kg for inorganics, ug/kg for organics.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are averaged into one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
COPCs selected for 20 or more samples collected is based on frequency of detection > 5%
COPCs selected for 19 or fewer samples collected is based on any single detection
Frequency of detection refers to number of times compound was detected among total samples.
Number of samples may vary based on the number of usable results.
Acronyms:
Min = Minimum
Max = Maximum
Arith = Arithmetic
COPC = Chemical of Potential Concern

TABLE 2-2
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN INDIGENOUS BLUE MUSSELS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Site-Related Data (wet weight)					
	Frequency of Detection	Frequency Percentage	Range of Positive Detection		Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
			Min.	Max.			
aluminum	8/8	100.00	7.8694	52.1668	20.16	Y	DSY-27
arsenic	8/8	100.00	0.3752	1.7584	1.015	Y	DSY-25
cadmium	8/8	100.00	0.0546	0.2604	0.12152	Y	DSY-24
chromium	8/8	100.00	0.3108	0.441	0.3724	Y	DSY-24
copper	8/8	100.00	0.1582	2.086	1.0738	Y	DSY-27
iron	8/8	100.00	15.092	61.2066	37.1	Y	DSY-24
lead	4/8	50.00	0.245	0.8134	0.2282	Y	DSY-24
manganese	8/8	100.00	0.3808	5.3648	2.338	Y	DSY-28
mercury	8/8	100.00	0.01658	0.03909	0.02422	Y	DSY-24
nickel	4/8	50.00	0.4802	0.7616	0.3136	Y	DSY-24
zinc	8/8	100.00	10.6862	19.9178	15.12	Y	DSY-27
1,6,7-trimethylnaphthalene	1/8	12.50	2.68247	2.68247	0.5656	Y	DSY-27
1-methylnaphthalene	1/6	16.67	2.08155	2.08155	0.6776	Y	DSY-25
1-methylphenanthrene	6/8	75.00	0.95012	6.9643	2.562	Y	DSY-27
2,6-dimethylnaphthalene	6/8	75.00	0.63823	6.14223	2.226	Y	DSY-24
2-methylnaphthalene	1/6	16.67	3.93035	3.93035	1.204	Y	DSY-25
acenaphthene	1/8	12.50	2.19268	2.19268	0.4368	Y	DSY-25
acenaphthylene	7/8	87.50	1.61113	12.5319	5.404	Y	DSY-26
anthracene	8/8	100.00	2.4816	33.1909	13.342	Y	DSY-26
benz(a)anthracene	8/8	100.00	2.13559	145.611	31.22	Y	DSY-26
benzo(a)pyrene	7/8	87.50	0.87301	76.7265	14	Y	DSY-26
benzo(b,j,k)fluoranthene	8/8	100.00	6.06151	323.4	63.28	Y	DSY-26
benzo(e)pyrene	8/8	100.00	5.17168	114.801	28.42	Y	DSY-26
benzo(g,h,i)perylene	6/8	75.00	1.40798	20.6657	4.746	Y	DSY-26
1,1-biphenyl	2/8	25.00	1.62809	1.80527	0.728	Y	DSY-27
chrysene	8/8	100.00	2.90685	87.612	25.2	Y	DSY-26

TABLE 2-2
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN INDIGENOUS BLUE MUSSELS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

	Site-Related Data (wet weight)						
Substance	Frequency of Detection	Frequency Percentage	Range of Positive Detection Min.	Max.	Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
dibenz(a,h)anthracene	3/8	37.50	1.10919	6.95425	1.2656	Y	DSY-26
fluoranthene	8/8	100.00	8.25122	183.4	67.06	Y	DSY-26
fluorene	8/8	100.00	0.70112	5.48064	2.898	Y	DSY-27
indeno(1,2,3-cd)pyrene	6/8	75.00	0.83875	16.9295	3.724	Y	DSY-26
naphthalene	3/6	50.00	2.11106	25.6388	7.854	Y	DSY-26
perylene	2/2	100.00	11.4746	25.7843	18.62	Y	DSY-26
phenanthrene	8/8	100.00	3.34687	38.1471	16.1	Y	DSY-27
pyrene	8/8	100.00	6.75265	145.6	49.56	Y	DSY-26
PCB 101 (2 2'3 5 5')	8/8	100.00	3.55516	7.94962	5.432	Y	DSY-27
PCB 105 (2 3 3'4 4')	8/8	100.00	0.55481	1.3489	0.9156	Y	DSY-27
PCB 118 (2 3'4 4'5)	8/8	100.00	2.69021	6.23645	4.046	Y	DSY-27
PCB 128 (2 2'3 3'4 4')	8/8	100.00	1.11234	3.22064	2.324	Y	DSY-40
PCB 138 (2 2'3 4 4'5)	8/8	100.00	6.56002	17.6102	11.844	Y	DSY-27
PCB 153 (2 2'4 4'5 5')	8/8	100.00	9.77274	24.1983	16.8	Y	DSY-27
PCB 170 (2 2'3 3'4 4'5)	8/8	100.00	0.22347	0.66073	0.4564	Y	DSY-24
PCB 18 (2 2'5)	3/8	37.50	0.38242	0.87441	0.3486	Y	DSY-27
PCB 180 (2 2'3 4 4'5 5')	8/8	100.00	1.17524	3.86548	2.184	Y	DSY-27
PCB 187 (2 2'3 4'5 5'6)	8/8	100.00	3.30917	7.80277	5.544	Y	DSY-27
PCB 195 (2 2'3 3'4 4'5 6)	4/8	50.00	0.1317	0.41608	0.1526	Y	DSY-28
PCB 206 (2 2'3 3'4 4'5 5'6)	8/8	100.00	0.27588	0.76789	0.4466	Y	DSY-26
PCB 209 (2 2'3 3'4 4'5 5'6	8/8	100.00	0.08883	1.16206	0.5152	Y	DSY-28
PCB 28 (2 4 4')	8/8	100.00	0.80965	2.29391	1.456	Y	DSY-26
PCB 44 (2 2'3 5')	8/8	100.00	0.77641	1.54731	1.022	Y	DSY-27
PCB 52 (2 2'5 5)	8/8	100.00	1.46656	3.05957	2.198	Y	DSY-28
PCB 66 (2 3'4 4')	1/8	12.50	0.577	0.577	0.308	Y	DSY-25
PCB 8 (2 4)	8/8	100.00	0.26342	1.04943	0.5866	Y	DSY-25

TABLE 2-2

OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN INDIGENOUS BLUE MUSSELS

MARINE HUMAN HEALTH RISK ASSESSMENT

FORMER DERECKTOR SHIPYARD

NETC - NEWPORT, RHODE ISLAND

PAGE 3 OF 3

	Site-Related Data (wet weight)					
Substance	Frequency of Detection	Frequency Percentage	Range of Positive Detection Min.	Max.	Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
pcb sum of congeners	8/8	100.00	36.9794	80.4002	56.28	Y	DSY-27
pcb sum of congeners x 2	8/8	100.00	73.9588	161	112.56	Y	DSY-27
mirex	8/8	100.00	0.0649	0.5168	0.3304	Y	DSY-28
o,p'-DDE	8/8	100.00	0.55215	1.25299	0.7644	Y	DSY-27
p,p'-DDE	8/8	100.00	0.67955	1.70096	1.2278	Y	DSY-35
dibutyltin	1/8	12.50	5.7232	5.7232	0.8988	Y	DSY-27
tributyltin	8/8	100.00	1.2852	136.781	20.3	Y	DSY-27

Notes:

Units are mg/kg for inorganics, ug/kg for organics.

Number of sample results excludes rejected data or blank-qualified data. Duplicates are averaged into one result.

Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.

COPCs selected for 20 or more samples collected is based on frequency of detection > 5%

COPCs selected for 19 or fewer samples collected is based on any single detection

Frequency of detection refers to number of times compound was detected among total samples.

Number of samples may vary based on the number of usable results.

Acronyms:

Min = Minimum

Max = Maximum

Arith = Arithmetic

COPC = Chemical of Potential Concern

TABLE 2-3
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN LOBSTER
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Site-Related Data (wet weight)					
	Frequency of Detection	Frequency Percentage	Range of Positive Detection Min. - Max.	Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
aluminum	3/9	33.33	0.5452 - 4.3546	0.7098	Y	DSY-27
arsenic	8/8	100.00	2.2722 - 4.0096	3.108	Y	DSY-25
cadmium	7/8	87.50	0.0224 - 0.0784	0.0455	Y	DSY-35
chromium	8/8	100.00	0.2296 - 0.3024	0.266	Y	DSY-35
copper	8/8	100.00	6.8824 - 27.565	17.78	Y	DSY-39
iron	9/9	100.00	3.9172 - 11.43	5.558	Y	DSY-27
lead	8/8	100.00	0.0097 - 0.1064	0.04298	Y	DSY-35
manganese	7/7	100.00	0.1946 - 0.6356	0.406	Y	DSY-39
mercury	8/8	100.00	0.0318 - 0.0636	0.04494	Y	DSY-27
nickel	8/8	100.00	0.1274 - 0.2632	0.2086	Y	DSY-38
silver	8/8	100.00	0.1148 - 0.9618	0.6636	Y	DSY-27
zinc	8/8	100.00	12.302 - 23.996	16.8	Y	DSY-38
1-methylnaphthalene	4/7	57.14	0.7384 - 1.8564	0.9688	Y	DSY-28
1-methylphenanthrene	4/9	44.44	6.2451 - 12.167	4.928	Y	DSY-33
2,6-dimethylnaphthalene	1/9	11.11	1.7586 - 1.7586	0.5222	Y	DSY-28
2-methylnaphthalene	4/7	57.14	1.0709 - 2.0838	1.253	Y	DSY-29
acenaphthene	1/9	11.11	4.556 - 4.556	0.6706	Y	DSY-27
anthracene	6/9	66.67	0.252 - 1.1487	0.5824	Y	DSY-27
benz(a)anthracene	2/9	22.22	3.4019 - 4.0607	1.0122	Y	DSY-27
benzo(a)pyrene	3/9	33.33	1.832 - 4.0216	1.2068	Y	DSY-27
benzo(b,j,k)fluoranthene	5/9	55.56	3.2154 - 8.5345	3.248	Y	DSY-27
benzo(e)pyrene	4/9	44.44	1.3523 - 2.817	1.1116	Y	DSY-28
benzo(g,h,i)perylene	3/9	33.33	1.1496 - 1.7734	0.5796	Y	DSY-29
1,1-biphenyl	2/9	22.22	1.1314 - 1.9929	0.658	Y	DSY-33
chrysene	2/9	22.22	4.3101 - 5.4021	1.365	Y	DSY-28
hexachlorobenzene	9/9	100.00	0.0328 - 0.176	0.10948	Y	DSY-35
fluoranthene	9/9	100.00	1.2927 - 14.068	6.664	Y	DSY-25
fluorene	1/9	11.11	2.0883 - 2.0883	0.3528	Y	DSY-29

TABLE 2-3
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN LOBSTER
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND
PAGE 2 OF 3

Substance	Site-Related Data (wet weight)					
	Frequency of Detection	Frequency Percentage	Range of Positive Detection Min. - Max.	Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
high molecular weight pahs	9/9	100.00	4.5524 - 39.874	18.9	Y	DSY-28
indeno(1,2,3-cd)pyrene	2/9	22.22	1.2091 - 1.4795	0.3822	Y	DSY-29
low molecular weight pahs	9/9	100.00	3.3298 - 12.73	7.448	Y	DSY-29
naphthalene	4/7	57.14	1.6799 - 4.9286	1.624	Y	DSY-33
perylene	2/9	22.22	1.5108 - 1.6647	0.5432	Y	DSY-28
phenanthrene	8/9	88.89	1.0444 - 4.5015	2.394	Y	DSY-28
pyrene	9/9	100.00	1.2661 - 17.302	7.98	Y	DSY-28
PCB 101 (2 2'3 5 5')	9/9	100.00	0.7304 - 5.2331	1.764	Y	DSY-39
PCB 105 (2 3 3'4 4')	9/9	100.00	0.3598 - 29.209	6.342	Y	DSY-36
PCB 118 (2 3'4 4'5)	9/9	100.00	1.8337 - 9.6505	4.41	Y	DSY-28
PCB 128 (2 2'3 3'4 4')	9/9	100.00	0.3203 - 1.7343	0.7546	Y	DSY-28
PCB 138 (2 2'3 4 4'5)	9/9	100.00	2.9749 - 9.9652	5.222	Y	DSY-28
PCB 153 (2 2'4 4'5 5')	9/9	100.00	4.2824 - 13.875	7.392	Y	DSY-28
PCB 170 (2 2'3 3'4 4'5)	9/9	100.00	0.7191 - 1.7114	1.001	Y	DSY-28
PCB 18 (2 2'5)	5/9	55.56	0.174 - 1.5016	0.441	Y	DSY-35
PCB 180 (2 2'3 4 4'5 5')	9/9	100.00	1.4806 - 4.7934	2.394	Y	DSY-28
PCB 187 (2 2'3 4'5 5'6)	9/9	100.00	1.3873 - 4.4095	2.212	Y	DSY-28
PCB 195 (2 2'3 3'4 4'5 6)	9/9	100.00	0.2247 - 0.6565	0.413	Y	DSY-28
PCB 206 (2 2'3 3'4 4'5 5'6)	9/9	100.00	0.5048 - 1.0099	0.7714	Y	DSY-39
PCB 209 (2 2'3 3'4 4'5 5'6 6')	9/9	100.00	0.4291 - 0.8094	0.5908	Y	DSY-39
PCB 28 (2 4 4')	9/9	100.00	0.5308 - 5.7118	1.3314	Y	DSY-39
PCB 44 (2 2'3 5')	9/9	100.00	0.0476 - 1.2118	0.658	Y	DSY-35
PCB 52 (2 2'5 5)	9/9	100.00	0.6735 - 1.8335	1.1914	Y	DSY-39
PCB 66 (2 3'4 4')	9/9	100.00	0.9525 - 2.7152	1.736	Y	DSY-39
PCB 8 (2 4)	5/9	55.56	0.252 - 1.0198	0.3654	Y	DSY-35
pcb sum of congeners	9/9	100.00	20.347 - 60.238	38.78	Y	DSY-28
pcb sum of congeners x 2	9/9	100.00	40.693 - 120.48	77.7	Y	DSY-28
mirex	9/9	100.00	0.0426 - 0.2167	0.11396	Y	DSY-33

TABLE 2-3
OCCURRENCE AND DISTRIBUTION OF ORGANICS AND INORGANICS IN LOBSTER
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND
PAGE 3 OF 3

Substance	Site-Related Data (wet weight)					
	Frequency of Detection	Frequency Percentage	Range of Positive Detection	Arith. Mean of All Data	Selected as a COPC?	Sampling Round and Location of Maximum
			Min. - Max.			
o,p'-DDE	2/9	22.22	0.5025 - 0.9924	0.1736	Y	DSY-39
p,p'-DDE	9/9	100.00	0.3339 - 1.3714	0.8624	Y	DSY-28

Notes:
Units are mg/kg for inorganics, ug/kg for organics.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are averaged into one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
COPCs selected for 20 or more samples collected is based on frequency of detection > 5%
COPCs selected for 19 or fewer samples collected is based on any single detection
Frequency of detection refers to number of times compound was detected among total samples.
Number of samples may vary based on the number of usable results.
Acronyms:
Min = Minimum
Max = Maximum
Arith = Arithmetic
COPC = Chemical of Potential Concern

TABLE 2-4
CONCENTRATIONS OF ORGANICS AND INORGANICS IN SEDIMENT SAMPLE DSY-29-S
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Concentration [1]
aluminum	37147.5
arsenic	12.46
cadmium	1.45
chromium	86.5
copper	157.75
iron	35452.5
lead	185.9
manganese	282.25
mercury	0.5
nickel	34.75
silver	0.79
zinc	392.75
1,6,7-trimethylnaphthalene	27.94
1-methylnaphthalene	50.07
1-methylphenanthrene	266.56
2,6-dimethylnaphthalene	112.32
2-methylnaphahalene	73.47
acenaphthene	188.59
acenaphthylene	300.15
anthracene	1220
benz(a)anthracene	2700
benzo(a)pyrene	2380
benzo(b,j,k)fluoranthene	5350
benzo(e)pyrene	1950
benzo(g,h,i)perylene	1110
1,1-biphenyl	29.91
chrysene	2800
dibenz(a,h)anthracene	317.43
fluoranthene	4970
fluorene	293.64
indeno(1,2,3-cd)pyrene	1020
naphthalene	76.08
perylene	610.95
phenanthrene	1609.54
pyrene	5300
PCB 101 (2 2'3 5 5')	16.7
PCB 105 (2 3 3'4 4')	6.61
PCB 118 (2 3'4 4'5)	18.38
PCB 128 (2 2'3 3'4 4')	5.14
PCB 138 (2 2'3 4 4'5)	27.04
PCB 153 (2 2'4 4'5 5')	22.8
PCB 170 (2 2'3 3'4 4'5)	7.25
PCB 18 (2 2'5)	0.68
PCB 180 (2 2'3 4 4'5 5')	13.79
PCB 187 (2 2'3 4'5 5'6)	8.54
PCB 195 (2 2'3 3'4 4'5 6)	3.83
PCB 206 (2 2'3 3'4 4'5 5'6)	17.39
PCB 209 (2 2'3 3'4 4'5 5'6 6')	105.27
PCB 28 (2 4 4')	1.66
PCB 44 (2 2'3 5')	3.94
PCB 52 (2 2'5 5)	9.69
PCB 66 (2 3'4 4')	3.87
PCB 8 (2,4)	0.6
PCB Sum of Congeners	273.19
PCB Sum of Congeners X 2	546.38
aldrin	0.1
hexachlorobenzene	0.16
mirex	0.1
o,p'-DDE	4.96
p,p'-DDE	6.29
dibutyltin	20.58
monobutyltin	8.65
tetrabutyltin	0.5
tributyltin	60.89

(1) Concentration units for Inorganics are mg/kg dry weight, Organics are ug/kg dry weight

2.3.3 Special Note Concerning PCB Concentrations Detected in Shellfish and Sediment

PCBs in shellfish and sediment were reported in the data set three ways; 1) Individual Common Congeners, 2) PCB Sum of the Congeners, and 3) PCB Sum of the Congeners x 2. This risk assessment used the following approach for estimating risks at DSY Offshore Areas for PCBs detected in shellfish and sediment:

2.3.3.1 Carcinogenic Risks

The "PCB Sum of the Congeners X 2" value is equal to the sum of the common congeners measured in the data set X 2. Additionally, this value is also approximately equal to the total Aroclors in a given sample. Therefore, for this risk assessment, PCB Sum of the Congeners X 2 will be used to estimate cancer risk.

2.3.3.2 Noncarcinogenic Risks

The PCB Sum of Congeners value is equal to the sum of the common congeners measured in the data set. For this report, this sum of PCB congeners was used for evaluation of noncarcinogenic risk, using a conservative assumption that all the congeners measured in the sample are derived from one specific PCB compound, Aroclor 1254. This assumption has been made because Aroclor 1254 is the only PCB compound for which noncarcinogenic toxicity information is available.

2.4 SUMMARY OF DATA

2.4.1 Shellfish

Tables 2-1, 2-2, and 2-3 summarize the analytical data for inorganic and organic constituents analyzed in hard shell clams (Table 2-1), indigenous blue mussels (Table 2-2), and lobster (Table 2-3) tissue samples and present the results of the COPC selection analysis (explained in Section 2.5).

These tables include data that have undergone evaluation for purposes of the HHRA (consideration of qualified data, duplicates, SQLs, and blanks as described in Section 2.3 is incorporated into the data summary). Each class of constituents is described below.

- Inorganics

  Hard Shell Clams (Table 2-1) - Twelve inorganic metals were detected in hard clam tissue samples (aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc). These inorganics were generally detected in greater than 60 percent of the samples, except for silver (detected in 3 out of 11 samples). SQLs for inorganics in hard shell clams are not unusually elevated and none of the mean concentrations exceed the maximum detected concentrations.

  Blue Mussels (Table 2-2) - Eleven inorganic metals were detected in blue mussel tissue samples (aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc). These inorganics were detected in all eight tissue samples, except for lead (detected in 4 of 8 samples) and nickel (detected in 4 of 8 samples). SQLs for inorganics in blue mussels are not unusually elevated and none of the mean concentrations exceeds the maximum detected concentrations.

  Lobsters (Table 2-3) - Twelve inorganic metals were detected in lobster tissue samples (aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc). These inorganics were generally detected in all lobster tissue samples collected, except for aluminum (detected in 3 of 9 samples) and cadmium (detected in 7 of 8 samples). SQLs for inorganics in lobsters are not unusually elevated and none of the mean concentrations exceeds the maximum detected concentrations.

- Semi-Volatile Organic Compounds

  Hard Shell Clams (Table 2-1) - Seventeen PAHs and one other SVOC were detected in hard shell clam tissue samples. Of the 17 PAHs, 1-methylphenanthrene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; chrysene; fluoranthene; fluorene; perylene; phenanthrene; and pyrene were all detected in more than 60 percent of

samples detected. The rest of the PAHs (acenaphthene, acenaphthylene, benzo(e)pyrene and indeno(1,2,3-cd)pyrene) were detected in between approximately 30 percent to 50 percent of samples analyzed. The other SVOC, hexachlorobenzene, was detected in 9 of 9 samples at a range of 0.021 ug/kg to 0.40 ug/kg. SQLs for SVOCs in hard shell clams are not unusually elevated and none of the mean concentrations for these constituents exceeds the maximum detected concentrations.

Blue Mussels (Table 2-2) - Twenty-two PAHs and one other SVOC were detected in blue mussel tissue samples. Of the 17 PAHs, 1-methylphenanthrene, 2,6-Dimethylnaphthalene; acenaphthylene; anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b,j,k)fluoranthene; benzo(e)pyrene; benzo(g,h,i)perylene; chrysene; fluoranthene; fluorene; perylene; phenanthrene; and pyrene were all detected in more than 75 percent of samples detected. The rest of the PAHs (1,6,7-trimethylnaphthalene, 1-methylphenanthrene, and 2-methylnaphthalene) were detected in between approximately 10 percent to 30 percent of samples analyzed. The other SVOC, biphenyl, was detected in 2 of 8 samples at a range of 1.63 ug/kg to 1.81 ug/kg. SQLs for SVOCs in blue mussels are not unusually elevated and none of the mean concentrations for these constituents exceeds the maximum detected concentrations.

Lobsters (Table 2-3) - Nineteen PAHs and two other SVOCs were detected in lobster tissue samples. Of the 19 PAHs, fluoranthene, phenanthrene, and pyrene were detect in greater than 90 percent of samples analyzed. The PAHs 1-methylnaphthalene; 1-methylphenanthrene; 2-methylnaphthalene; anthracene; benzo(a)pyrene; benzo(b,j,k)fluoranthene; benzo(e)pyrene; benzo(g,h,i)perylene; and naphthalene were detected in between approximately 30 percent to 50 percent of samples analyzed. The rest of the PAHS (2,6-Dimethylnaphthalene, acenaphthene, benzo(a)anthracene, chrysene, fluorene, indeno(1,2,3-cd)pyrene, and perylene) were detected between approximately 10 percent to 20 percent of samples analyzed. The other two SVOCs; biphenyl, was detected in 2 of 9 samples at a range of 1.31 ug/kg to 1.99 ug/kg; and hexachlorobenzene was detected in 9 of 9 samples at a range of 0.03 ug/kg to 0.18 ug/kg. SQLs for SVOCs in lobsters are

not unusually elevated and none of the mean concentrations for these constituents exceeds the maximum detected concentrations.

- PCBs

Hard Shell Clams (Table 2-1) - Seventeen different PCB congeners were detected in hard shell clam tissue samples. The PCB congeners in hard shell clams were generally detected in all samples. PCBs, based on a total sum of the congeners, ranged from 11.15 ug/kg to 66.53 ug/kg. Total PCBs (PCB Sum of the Congeners x 2), ranged from 22.31 ug/kg to 133.07 ug/kg. SQLs for PCBs in hard shell clams are not unusually elevated and the mean concentrations of these constituents do not exceed the maximum detected concentrations.

Blue Mussels (Table 2-2) - Seventeen different PCB congeners were detected in blue mussel tissue samples. The PCB congeners in blue mussels were generally detected in all samples. PCBs, based on a total sum of the congeners, ranged from 36.98 ug/kg to 80.40 ug/kg. Total PCBs (PCB Sum of the Congeners x 2), ranged from 73.96 ug/kg to 161 ug/kg. SQLs for PCBs in blue mussels are not unusually elevated and the mean concentrations of these constituents do not exceed the maximum detected concentrations.

Lobsters (Table 2-3) - Eighteen different PCB congeners were detected in lobster tissue samples. The PCB congeners in lobster were generally detected in all samples. PCBs, based on a total sum of the congeners, ranged from 20.35 ug/kg to 60.24 ug/kg. Total PCBs (PCB Sum of the Congeners x 2), ranged from 40.69 ug/kg to 120.48 ug/kg. SQLs for PCBs in lobsters are not unusually elevated and the mean concentrations of these constituents do not exceed the maximum detected concentrations.

- Pesticides

Hard Shell Clams (Table 2-1) - Three pesticides were detected in hard shell clam tissue samples. Mirex was detected 8 of 8 samples at a range of 0.03 ug/kg to 0.15 ug/kg; o,p'-DDE was detected in 5 of 10 samples at a range of 0.16 ug/kg to

0.54 ug/kg; and p,p'-DDE was detected in 10 of 10 samples at a range of 0.21 ug/kg to 0.66 ug/kg. SQLs for pesticides in hard shell clams are not unusually elevated and the mean concentrations these constituents do not exceed the maximum detected concentrations.

Blue Mussels (Table 2-2) - Three pesticides were detected in blue mussel tissue samples. Mirex was detected 8 of 8 samples at a range of 0.06 ug/kg to 0.52 ug/kg; o,p'-DDE was detected in 8 of 8 samples at a range of 0.55 ug/kg to 1.25 ug/kg; and p,p'-DDE was detected in 8 of 8 samples at a range of 0.68 ug/kg to 1.70 ug/kg. SQLs for pesticides in blue mussels are not unusually elevated and the mean concentrations of these constituents do not exceed the maximum detected concentrations.

Lobsters (Table 2-3) - Three pesticides were detected in lobster tissue samples. Mirex was detected 9 of 9 samples at a range of 0.04 ug/kg to 0.22 ug/kg; o,p'-DDE was detected in 2 of 9 samples at a range of 0.50 ug/kg to 0.99 ug/kg; and p,p'-DDE was detected in 9 of 9 samples at a range of 0.33 ug/kg to 1.37 ug/kg. SQLs for pesticides in lobsters are not unusually elevated and the mean concentrations these constituents do not exceed the maximum detected concentrations.

- Butylin

Hard Shell Clams (Table 2-1) - Tributyltin was detected in 6 of 6 samples at a range of 4.29 ug/kg to 9.40 ug/kg. SQLs for tributyltins are not unusually elevated and the mean concentration of tributyltin does not exceed the maximum detected concentration.

Blue Mussels (Table 2-2) - Tributyltin was detected in 8 of 8 samples at a range of 1.29 ug/kg to 136.78 ug/kg. Dibutyltin was detected in only one sample at 5.72 ug/kg. SQLs for butyltins are not unusually elevated and the mean concentrations of dibutyltin or tributyltin do not exceed the maximum detected concentrations.

Lobsters (Table 2-3) - Butyltins were not detected in lobster tissue samples.

2.4.2 Sediment

Table 2-4 summarizes the analytical data for inorganic and organic constituents analyzed in sediment at sampling location DSY-29-S. These tables include data that have undergone evaluation for purposes of the HHRA (consideration of qualified data, duplicates, SQLs, etc. as described in Section 2.3 is incorporated into the data summary). Each class of constituents is described below.

- Inorganics

  Twelve inorganic metals were detected in sediment sample DSY-29-S (aluminum, 37,147.5 mg/kg; arsenic, 12.46 mg/kg; cadmium, 1.45 mg/kg; chromium, 86.5 mg/kg; copper, 157.75; iron, 35,452.5 mg/kg; lead, 185.9 mg/kg; manganese, 282.25 mg/kg; mercury, 0.5 mg/kg; nickel, 34.75 mg/kg; silver, 0.79 mg/kg; and zinc, 392.75 mg/kg). SQLs for inorganics in sediment sample DSY-29-S are not unusually elevated.

- Semi-Volatile Organic Compounds

  Twenty-two PAHs (1,6,7-trimethylnaphthalene, 1-methylnaphthalene, 1-methylphenanthrene; 2,6-dimethylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene; benzo(a)anthracene; benzo(a)pyrene; benzo(b,j,k)fluoranthene; benzo(e)pyrene; benzo(g,h,i)perylene; chrysene; dibenz(a,h)anthracene, fluoranthene; fluorene; indeno(1,2,3-cd)pyrene, naphthalene, perylene; phenanthrene; and pyrene were detected in sediment sample DSY-29-S at a range of 7.94 ug/kg to 5350 ug/kg. Two other SVOCs, hexachlorobenzene and 1,1-biphenyl were detected at concentrations of 0.16 ug/kg and 29.91 ug/kg, respectively. SQLs for SVOCs in sediment sample DSY-29-S are not unusually elevated. PAHs in this sediment sample were the highest detected among all marine sediment stations sampled under this project.

- PCBs

  Eighteen different PCB congeners were detected in the sediment sample DSY-29-S.

PCBs, based on a total sum of the congeners were present in DSY-29-S at 273.19 ug/kg. Total PCBs (PCB Sum of the Congeners x 2) was present in DSY-29-S at 546.38 ug/kg. SQLs for PCBs in sediment sample DSY-29-S are not unusually elevated. PCBs in this sediment sample were the second highest detected (sum congeners X 2 = 546 mg/kg) out of all stations sampled under this project.

- Pesticides

Four pesticides were detected in sediment sample DSY-29-S. Aldrin was detected at a concentration of 0.1 ug/kg; Mirex was detected at a concentration of 0.1 ug/kg; o,p'-DDE was detected at a concentration of 4.96 ug/kg; p,p'-DDE was detected at a concentration of 6.29 ug/kg. SQLs for pesticides in sediment sample DSY-29-S are not unusually elevated.

- Butyltins

Four butyltins were detected in sediment sample DSY-29-S. Monobutyltin was detected at a concentration of 8.65 ug/kg; Dibutyltin was detected at a concentration of 20.58 ug/kg; tributyltin was detected at a concentration of 60.89 ug/kg; and tetrabutyltin was detected at a concentration of 0.5 ug/kg. SQLs for butyltins in sediment sample DSY-29-S are not unusually elevated.

2.5 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN

2.5.1 Shellfish

A number of general factors are considered in selecting the COPCs for each shellfish tissue medium evaluated in the HHRA. These factors include: (i) detection frequency and (ii) essential nutrient status. The purpose of the selection process is to identify the potentially site-related constituents that are likely to contribute significantly to the estimates of risk. Constituents in a medium are excluded from further consideration in the HHRA based on one or more of the following conditions:

- The constituent was not detected, or if detected, was found at a frequency less than 5 percent. If fewer than 20 samples were collected for a constituent in the medium under consideration, a single detection leads to the inclusion of this constituent as a COPC.

- The constituent is an essential nutrient, i.e., calcium, iron, magnesium, potassium, sodium (as agreed to by EPA (1994b).

Although this approach does not consider several other factors discussed by EPA (1989a,b) such as toxicity, mobility, persistence, bioaccumulation, constituent treatability, available cleanup standards, it is inclusive rather exclusive in nature and is reasonable for use in the HHRA.

The selection of COPCs in hard shell clams, blue mussels, and lobster tissue is shown in Tables 2-1, 2-2, and 2-3, respectively. These tables show that every chemical detected was selected as a COPC because less than 20 samples were collected in each of the three tissue sample types. Only essential nutrients were eliminated from consideration in this HHRA.

In hard shell clam tissue samples, 12 inorganics, 18 SVOCs, 17 PCB congeners, and 3 pesticides were selected as COPCs. In blue mussel tissue samples, 11 inorganics, 23 SVOCs, 17 PCB congeners, and 3 pesticides were selected as COPCs. In lobster tissue samples, 12 inorganics, 21 SVOCs, 18 PCB congeners, and 3 pesticides were selected as COPCs.

2.5.2 Sediment

All constituents detected in DSY-29-S (Table 2-4) will be selected as COPCs for the trespasser exposure scenarios. In the sediment sample, 12 inorganics, 24 SVOCs, 18 PCB congeners, 4 pesticides, and 4 butyltins were selected as COPCs.

3.0 CONSTITUENT FATE AND TRANSPORT

This section provides an overview of the potential routes of constituent migration in shellfish and sediment and evaluates the fate and transport of constituents detected in shellfish harvested for areas offshore of the former Derecktor Shipyard.

3.1 POTENTIAL ROUTES OF MIGRATION

The media investigated in the RI include shellfish and sediment. Detections in shellfish and near-shore sediment may reflect naturally occurring constituents, site-related constituents, and/or constituents present throughout Narragansett Bay. Constituents detected at off-shore locations are more difficult to characterize as being site-related than those found near-shore. Constituents present in shellfish may be ingested by animals or humans. Constituents present in sediments can be transported through the action of the tide and surf on the shoreline.

Information concerning environmental fate (persistence in various media, transport between media) of a constituent is provided primarily from the physical, chemical, and environmental fate properties specific to that constituent. To evaluate the fate of constituents detected in environmental media, information on these physical, chemical, and environmental fate properties was collected for the constituents identified as COPCs in shellfish in the HHRA.

The information collected for COPCs is shown in Table 3-1 and includes the following:

- Molecular formula
- Molecular weight
- Organic carbon-water partition coefficient (K_{oc})
- Half-life in soil
- Water solubility
- Octanol-water partition coefficient (K_{ow})
- Half-life in surface water
- Vapor pressure
- Henry's Law constant
- Diffusivity in air

TABLE 3-1
SUMMARY OF CHEMICAL, PHYSICAL, AND ENVIRONMENTAL FATE PARAMETERS FOR COPCs
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Chemical	Molecular Formula	Molecular Weight	Koc		Water Solubility (mg/L)		Kow		Vapor Pressure (mg/L)		Henry's Law Constant (atm*m3/mol)		Bioconcentration Factor	
Metals														
ALUMINUM	Al	26.9800	NA	2	Insoluble	2	NA	2	NA	2	NA	2	NA	3
ARSENIC	As	74.9200	NA	2	Insoluble	2	NA	2	NA	2	NA	2	4.40E+01	3
CADMIUM	Cd	112.4000	NA	2	Insoluble	2	NA	2	NA	2	NA	2	6.40E+01	3
COPPER	Cu	63.5400	NA	2	Insoluble	2	NA	2	NA	2	NA	2	3.60E+01	3
CHROMIUM (VI)	Cr	52.0000	NA	2	NA	2	NA	2	NA	2	NA	2	1.60E+01	3
IRON	Fe	55.8500	NA	2	Insoluble	2	NA	2	N	2	NA	2	NA	3
LEAD	Pb	207.1900	NA	2	Insoluble	2	NA	2	NA	2	NA	2	1.00E+00	3
MANGANESE	Mg	54.9400	NA	1	NA	1	NA	1	NA	1	NA	2	1.00E+00	3
MERCURY	Hg	200.5900	NA	2	5.60E-02	2	NA	2	2.00E-03	1	1.10E-02	2	1.00E+00	3
NICKEL	Ni	58.7100	NA	2	Insoluble	2	NA	2	NA	2	NA	2	4.70E+01	3
SILVER	Ag	107.8700	NA	2	Insoluble	2	NA	2	NA	2	NA	2	5.00E-01	3
ZINC	Zn	65.3700	NA	2	Insoluble	2	NA	2	NA	2	NA	2	4.70E+01	3
Semivolatile Organic Compounds														
ACENAPHTHENE	C12H10	154.2000	1.80E+01	4	3.40E+00	2	8.30E+03	2	1.60E-03	4	2.40E-04	2	2.42E+02	3
ACENAPHTHYLENE	C12H8	152.2000	4.80E+03	4	3.90E+00	2	1.20E+03	2	2.90E-02	2	1.10E-04	2	1.00E+03	3
ANTHRACENE	C14H10	178.2300	2.00E+04	4	1.30E+00	2	2.80E+04	2	2.00E-04	2	8.60E-05	2	3.00E+01	3
BENZ(A)ANTHRACENE	C18H12	228.2800	1.40E+06	4	1.20E-02	4	4.10E+05	2	1.10E-07	4	6.60E-07	2	3.00E+01	3
BENZO(A)PYRENE	C20H12	252.3200	1.20E+06	4	3.80E-03	2	9.50E+05	2	5.60E-08	4	4.90E-07	2	3.00E+01	3
BENZO(E)PYRENE	C20H12	252.3200	1.20E+06	4	3.80E-03	2	9.50E+05	2	5.60E-08	4	4.90E-07	2	3.00E+01	3
BENZO(G,H,I)PERYLENE	C12H22	276.3400	7.80E+06	4	2.60E-04	2	1.70E+07	2	1.00E-10	2	1.40E-07	2	3.00E+01	3
1,1-BIPHENYL	C12H10	154.2000	NA	4	NA	2	1.20E+04	2	NA (6)		NA	2	NA	3
CHRYSENE	C18H12	228.2900	2.50E+05	4	6.00E-03	2	4.10E+05	2	6.30E-09	2	1.10E-06	2	3.00E+01	3
DIBENZ(A,H)ANTHRACENE	C22H14	278.3500	1.70E+06	4	5.00E-04	2	9.00E+05	2	1.00E-10	2	7.30E-08	2	6.90E+05	3
2,6-DIMETHYLNAPHTHALENE	C12H12	156.1900	NA		NA		NA		NA		NA		NA	3
FLUORANTHENE	C16H10	202.2600	4.20E+04	4	2.70E-01	2	2.10E+05	2	5.00E-06	2	6.50E-06	2	1.15E+03	3
FLUORENE	C13H10	166.2200	5.00E+03	4	1.90E+00	2	1.50E+04	2	7.10E-04	2	1.20E-04	2	3.80E+03	3
HEXACHLOROBENZENE	C6CL6	285.0000	NA		6.20E+00		5.89E+00		1.00E-05		1.32E-03		NA	3
INDENO(1,2,3-CD)PYRENE	C22H12	276.3400	3.10E+07	4	6.20E-02	2	4.60E+07	2	1.00E-10	2	7.00E-08	2	3.00E+01	3
1-METHYLNAPHTHALENE	C11H10	142.1900	8.00E+03	4	2.60E+01	2	7.20E+03	2	NA	2	5.00E-04	2	1.00E+03	3
2-METHYLNAPHTHALENE	C11H10	142.1900	8.00E+03	4	2.60E+01	2	7.20E+03	2	NA	2	5.00E-04	2	1.00E+03	3
1-METHYLPHENANTHRENE	C16H12	192.2300	NA		NA		NA		NA		NA		NA	3
NAPHTHALENE	C10H8	128.1900	1.60E+03	4	3.00E+01	2	2.30E+03	2	8.20E-02	2	4.80E-04	2	1.05E+01	3
PERYLENE	C20H12	252.3000	NA		NA		NA		NA		NA		NA	3
PHENANTHRENE	C14H10	178.2300	2.20E+04	4	1.00E+00	4	2.90E+04	2	6.80E-04	4	3.90E-05	2	3.00E+01	3
PYRENE	C16H10	202.2600	7.30E+04	4	1.60E-01	2	1.50E+05	2	1.50E-07	4	5.10E-06	2	3.00E+01	3
1,6,7-TRIMETHYLNAPHTHALENE	C13H14	170.1900	NA		NA		NA		NA		NA		NA	3
PCBS														
PCBS (Varies by Congener)														
Pesticides														
4,4'-DDE	C14H8CL4	319.0300	6.20E+05	4	8.00E-02	4	4.90E+05	4	NA	2	2.30E-05	2	5.36E+04	3
ALDRIN	C12H8CL6	354.5000	NA		1.70E-02	4	5.11E+00	4	1.90E-07	2	1.58E-05	2	8.00E+06	3
MIREX	NA	NA	NA		NA		NA		NA		NA		NA	3
Butyltins														
DIBUTYLTIN	C8H18Sn	233.0000	NA		NA		NA		NA		NA		NA	3
MONOBUTYLTIN	C4H9Sn	176.0000	NA		NA		NA		NA		NA		NA	3
TETRABUTYLTIN	C16H36Sn	347.0000	NA		NA		NA		NA		NA		NA	3
TRIBUTYLTIN	C12H27Sn	290.0000	NA		NA		NA		NA		NA		NA	3

NA = Not Available
Reference [1] = EPA 1986
Reference [2] = EPA 1992
Reference [3] = EPA 1996
Reference [4] = Montgomery and Welkum (1990)

The organic carbon-water partition coefficient (K_{oc}) provides a measure of the partitioning of a constituent between organic carbon and water, and is a useful indicator of the tendency of a constituent to bind to soil versus leach into water. The higher the K_{oc}, the more likely a constituent is to bind to soil or sediment than to remain in water.

Water solubility (mg/L) is defined as the maximum concentration of a constituent that dissolves in pure water at a specific temperature. Water solubility affects environmental fate such that highly soluble constituents are generally mobile in soil, and surface and groundwater.

The octanol-water partition coefficient (K_{ow}) provides a measure of the expected partitioning of a constituent between octanol and water. The greater the K_{ow}, the more likely a constituent is to partition into octanol (or other lipophilic phases) than to remain in water.

Constituent volatility can be measured as vapor pressure and Henry's Law constant. Vapor pressure (mm Hg) is defined as a relative measure of the volatility of a constituent in its pure state. The higher the vapor pressure, the more likely a constituent is to exist in a gaseous phase. Henry's Law constant (atm-m^3/mol) combines vapor pressure with solubility and molecular weight. The higher the Henry's Law constant, the more likely a constituent is to volatilize than to remain in water. Vapor pressure is an important measure when considering releases from soil and sediment, while Henry's Law constant is more appropriate for volatilization from water. Diffusivity in air (cm^2/s) provides a measure of the rate at which a constituent will move through air across a concentration gradient. Factors that determine diffusivity in air include the relative size of air molecules versus the size of those for the constituents of interest, temperature, and ambient pressure.

Finally, persistence in the environment may be characterized by a half-life such that the greater the half-life, the more persistent the constituent is likely to be in that medium.

3.2 CONSTITUENT DISTRIBUTION AND OBSERVED MIGRATION

The presence of constituents in environmental media in areas offshore of the former Derecktor Shipyard is discussed in combination with potential migration pathways to provide an understanding of constituent persistence and migration at the site. The discussions below are presented with respect to individual constituents or constituent groups, with an emphasis on

constituents identified as COPCs. The COPCs identified for shellfish and/or sediment include inorganics, SVOCs (primarily PAHs), pesticides, PCBs, and butyltins.

3.2.1 Inorganics

Inorganics identified as COPCs in shellfish and sediment evaluated include aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, and zinc. Some species of shellfish in areas offshore of the former Derecktor Shipyard may move out the area and/or be consumed by animals and humans. The main route of migration for sediments would be through surface water runoff and tidal action. Inorganics may be present in shellfish and sediment as a result of background conditions, site-related impacts, and/or other point/non-point source contributions to Narragansett Bay.

3.2.2 Semi-Volatile Organic Compounds

SVOCs identified as COPCs that were detected in shellfish and sediment consist mainly of PAHs. Shellfish may move out the area and/or be consumed by animals and humans. As in soil, PAHs tend to bind to sediment (high K_{oc}s) and have low solubility in water. PAHs in shoreline/near-shore sediments may be transported off-shore with surface water runoff and by tidal action. SVOCs may be present in shellfish and sediment as a result of background conditions, site-related impacts, and/or other point/non-point source contributions to Narragansett Bay.

3.2.3 PCBs and Pesticides

Many PCB congeners were identified as COPCs in shellfish and sediment samples. Two pesticides, mirex and DDE, were also identified as COPCs in shellfish samples. Three pesticides, aldrin, mirex, and DDE, were also identified as COPCs in sediment. Shellfish in DSY Offshore Areas may move out of the area and/or be consumed by animals and humans. Tidal erosion would be the main transport mechanism for sediment. PCBs and pesticides may be present in shellfish and sediment as a result of background conditions, site-related impacts, and/or other point/non-point source contributions to Narragansett Bay.

3.2.4 Butyltins

Two butyltins, di- and tri-, were identified as COPCs in shellfish samples. Four butyltins, mono-, di-, tri-, and tetra- were identified as COPCs in sediment samples. Shellfish may move out of the area and/or be consumed by animals and humans. Tidal erosion would be the main transport mechanism for sediment. Butyltins may be present in shellfish and sediment as a result of background conditions, site-related impacts, and/or other point/non-point source contributions to Narragansett Bay.

4.0 DOSE-RESPONSE ASSESSMENT

This section presents the toxicity criteria for evaluating the potential carcinogenic risk and non-carcinogenic effects associated with the identified COPCs. If available, cancer and non-cancer toxicity values from EPA's Integrated Risk Information System (IRIS) database (EPA 1997a) or EPA's (1997b) Health Effects Assessment Summary Tables (HEAST) are used estimate risks. For those constituents without the above mentioned toxicity criteria, a qualitative discussion of risk is provided in Section 6.2. The cancer and non-cancer values used for COPCs in the HHRA are presented in Table 4-1 and Table 4-2, respectively. Appendix B provides toxicity profiles that summarize the basis for each of these values.

4.1 TOXICITY INFORMATION FOR CARCINOGENIC EFFECTS

For potential carcinogens, risks are estimated as probabilities. The constituent-specific slope factors for carcinogens (in units of (mg/kg-d)-1) are generally estimated through the use of mathematical extrapolation models (the linearized multistage model). These models estimate the largest possible linear slope, within a 95 percent confidence interval, at low extrapolated doses. Thus, the slope factor is characterized as a 9 percent upper-bound estimate, such that the true risk is not likely to exceed the upper-bound estimate and may be lower. In addition to identifying cancer slope factors, the EPA classifies constituents with regard to their relative carcinogenicity. The classification scheme follows (EPA, 1993a).

Classification	Basis
Group A - Human Carcinogen	Sufficient evidence of carcinogenicity in humans.
Group B1 - Probable Human Carcinogen	Limited evidence in humans.
Group B2 - Probable Human Carcinogen	Sufficient evidence in animals with inadequate or lack of evidence in humans.
Group C - Possible Human Carcinogen	Limited evidence in animals with inadequate or lack of evidence in humans.
Group D - Not Classifiable	Inadequate or lack of evidence.
Group E - No evidence of Carcinogenicity	No evidence in adequate studies.

Table 4-1 summarizes the available toxicity criteria for carcinogenic effects related to oral exposure. For each COPC, the tables contain the available cancer slope factor, EPA's weight-of-evidence classification, the type of cancer, and the source of the cancer slope factor.

TABLE 4-1
DOSE-RESPONSE PARAMETERS - CARCINOGENIC EFFECTS
CHEMICALS OF POTENTIAL CONCERN
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

COPC	SF Oral 1/(mg/kg)/day		Weight of Evidence	Type of Cancer	SF Basis/ Source
Semivolatiles					
1,6,7-trimethylnaphthalene	NA				NA/IRIS,HEAST
1-methylnaphthalene	NA				NA/IRIS,HEAST
1-methylphenanthrene	NA				NA/IRIS,HEAST
2,6-dimethylnaphthalene	NA				NA/IRIS,HEAST
2-methylnaphthalene	NA				NA/IRIS,HEAST
acenaphthene	NA				NA/IRIS,HEAST
acenapthtylene	NA				NA/IRIS,HEAST
anthracene	NA				NA/IRIS,HEAST
benz(a)anthracene	7.3E-01	E	B2	Forestomach	Diet/IRIS
benzo(a)pyrene	7.3E+00		B2	Forestomach	Diet/IRIS
benzo(b,j,k)flouranthene*	7.3E-01	E	B2	Forestomach	Diet/IRIS
benzo(e)pyrene	NA				NA/IRIS,HEAST
benzo(g,h,i)perylene	NA				NA/IRIS,HEAST
biphenyl	NA				NA/IRIS,HEAST
chrysene	7.3E-03	E	B2	Forestomach	Diet/IRIS
dibenz(a,h)anthracene	7.3E+00	E	B2	Forestomach	Diet/IRIS
fluoranthene	NA				NA/IRIS,HEAST
fluorene	NA				NA/IRIS,HEAST
hexachlorobenzene	1.6E+00		B2	Liver, Thyroid, Kidney	Water/IRIS
indeno(1,2,3-cd)pyrene	7.3E-01	E	B2	Forestomach	Diet/IRIS
naphthalene	NA				NA/IRIS,HEAST
perylene	NA				NA/IRIS,HEAST
phenanthrene	NA				NA/IRIS,HEAST
pyrene	NA				NA/IRIS,HEAST
Pesticides/PCBs					
Polychlorinated biphenyls	2.0E+00		B2	Liver	Diet/IRIS
Aldrin	1.7E+01		B2	Liver	Diet/IRIS
Mirex	1.8E+00	W	B2		
DDE	3.4E-01		B2	Liver	Diet/IRIS
Metals					
aluminum	NA				NA/IRIS,HEAST
arsenic	1.5E+00		A	Skin	Water/IRIS
cadmium	NA				NA/IRIS,HEAST
chromium	NA		D		NA/IRIS,HEAST
copper	NA		D		NA/IRIS,HEAST
iron	NA				NA/IRIS,HEAST
lead	NA		B2	Kidney	NA/IRIS,HEAST
manganese (food)	NA		D		NA/IRIS,HEAST
mercury	NA		D		NA/IRIS,HEAST
nickel	NA				NA/IRIS,HEAST
silver	NA		D		NA/IRIS,HEAST
zinc	NA		D		NA/IRIS,HEAST
Butyltins					
Dibutyltin	NA				NA/IRIS,HEAST
Tributyltin	NA				NA/IRIS,HEAST

COPC = Chemical of Potential Concern

SF = Slope Factor

IRIS = Integrated Risk Information System (EPA, 1997a)

HEAST = Health Effects Assessment Summary Tables (EPA, 1997b)

NA = Not Available

E = EPA-NCEA Regional Support provisional service

W = Withdrawn from IRIS or HEAST

* = Benzo(b,j,k)fluoranthene is a combination of Benzo(b)fluoranthene & Benzo(k)fluoranthene & Benzo(j)fluoranthene, the value used for the carcinogenic risk assessment represents the toxicity of Benzo(b)fluoranthene

TABLE 4-2
DOSE-RESPONSE PARAMETERS - NONCARCINOGENIC EFFECTS
CHEMICALS OF POTENTIAL CONCERN
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC-NEWPORT, RHODE ISLAND

COPC	RfD Oral (mg/kg)/day	Confidence Level	Type Critical Effect	Oral RfD Basis/Source	Uncertainty Factor	Modifying Factor
Semivolatiles						
1,6,7-trimethylnaphthalene	NA			NA/IRIS,HEAST		
1-methylnaphthalene	4.0E-02		Decreased Body Weight Gain	Gavage/HEAST	10000	NA
1-methylphenanthrene	NA			NA/IRIS,HEAST		
2,6-dimethylnaphthalene	NA			NA/IRIS,HEAST		
2-methylnaphthalene	4.0E-02		Decreased Body Weight Gain	Gavage/HEAST	10000	NA
acenaphthene	6.0E-02	Low	Hepatotoxicity	Gavage/IRIS	3000	1
acenapthtylene	NA			NA/IRIS,HEAST		
anthracene	3.0E-01	Low	None Observed	Gavage/IRIS	3000	1
benz(a)anthracene	NA			NA/IRIS,HEAST		
benzo(a)pyrene	NA			NA/IRIS,HEAST		
benzo(b,j,k)flouranthene	NA			NA/IRIS,HEAST		
benzo(e)pyrene	NA			NA/IRIS,HEAST		
benzo(g,h,i)perylene	NA			NA/IRIS,HEAST		
biphenyl	5.0E-02	Medium	Kidney Damage	Diet/IRIS,HEAST	100	10
chrysene	NA			NA/IRIS,HEAST		
dibenz(a,h)anthracene	NA			NA/IRIS,HEAST		
fluoranthene	4.0E-02	Low	Kidney, Liver, Blood	Gavage/IRIS	3000	1
fluorene	4.0E-02	Low	Hematological Effects	Gavage/IRIS	3000	1
hexachlorobenzene	8.0E-04	Medium	Liver	Diet/IRIS,HEAST	100	1
indeno(1,2,3-cd)pyrene	NA			NA/IRIS,HEAST		
naphthalene	4.0E-02		Decreased Body Weight Gain	Gavage/Heast	1000	NA
perylene	NA			NA/IRIS,HEAST		
phenanthrene	NA			NA/IRIS,HEAST		
pyrene	3.0E-02	Low	Kidney Effects	Gavage/IRIS	3000	1
Pesticides/PCBs						
Polychlorinated biphenyls	NA			NA/IRIS,HEAST		
PCBs as Aroclor-1254	2.0E-05	Medium	Ocular, Skin, Decreased Antibody Responses in Erythrocytes	Diet/IRIS	300	
Aldrin	3.0E-05	Medium	Liver, Central Nervous System	Diet/IRIS		
Mirex	2.0E-04	High	Liver	Diet/IRIS,HEAST	300	1
DDE	NA			NA/IRIS,HEAST		
Metals						
aluminum	1.0E+00 E			EPA/NCEA		
arsenic	3.0E-04	Medium	Hyperpgmentation, Keratosis, Vascular Effects	Water/IRIS	3	1
cadmium	1.0E-03	High	Proteinurea	Diet/IRIS	10	1
chromium	5.0E-03	Low	None Observed	Water/IRIS	500	1
copper	4.0E-02		Local GI Irritation	Oral/HEAST	NA	NA
iron	3.0E-01 E		Pancreas and Liver	EPA/NCEA		
lead	NA			NA/IRIS,HEAST		
manganese (food)	1.4E-01		Central Nervous System	Diet/IRIS	1	1
mercury	3.0E-04		Kidney	Oral/HEAST	1000	NA
nickel	2.0E-02	Medium	Reduced Body and Organ Weight	Diet/IRIS	300	1
silver	5.0E-03	Low	Dermal Effects	Diet/IRIS	3	1
zinc	3.0E-01	Medium	Anemia	Diet/IRIS	3	1
Butyltins						
Dibutyltin	NA			NA/IRIS,HEAST		
Tributyltin	3.0E-04	High	Immunosupression	Diet/IRIS,HEAST	100	1

COPC = Chemical of Potential Concern
RfD = Reference Dose
IRIS = Integrated Risk Information System (EPA, 1997a)
HEAST = Health Effects Assessment Summary Tables (EPA, 1997b)
NA = Not Available
E = EPA-NCEA Regional Support provisional service
W = Withdrawn from IRIS or HEAST

Carcinogenic PAHs are related by chemical structure. Only benzo(a)pyrene has an EPA published slope factor (EPA, 1995g). All other carcinogenic PAHs have slope factors based on their potency relative to benzo(a)pyrene. These factors are published by EPA (1995a). The relative potency factors for COPCs are as follows for PAHS:

Constituent	Relative Potency Factor
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1*
Benzo(k)fluoranthene	0.01*
Chrysene	0.001
Dibenzo(a,h)anthracene	1.0
Indeno(1,2,3-cd)pyrene)	0.1

***Special Note:** The shellfish tissue and sediment samples analyzed for benzo(b)fluoranthene and benzo(k)fluoranthene were reported by the laboratory together as benzo(b,j,k)fluoranthene. Therefore, the more conservative (higher) of the relative potency factors of these two compounds [benzo(b)fluoranthene, RPF = 0.1 of benzo(a)pyrene's toxicity value] will be used in this risk assessment and applied to the concentrations reported by the laboratory as benzo(b,j,k)fluoranthene.

4.2 TOXICITY INFORMATION FOR NON-CARCINOGENIC EFFECTS

The evaluation of the potential for non-cancer (systematic) effects from exposure to non-carcinogens is based on the use of RfDs. RfDs have units of mg/kg-day, and are estimates of daily exposure to the population (including sensitive subpopulations) that are likely to be without appreciable risk of deleterious effects for the defined exposure period (subchronic or chronic). The RfD is calculated by dividing the no adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) derived from animal or human studies by an uncertainty and/or modifying the factor. RfDs incorporate uncertainty factors, which serve as a conservative downward adjustment of the numerical value, and reflect scientific judgment regarding the data used to estimate the RfD. For example, a factor of 10 is used to account for variations in human sensitivity (to protect sensitive subpopulations) when the data stems from human studies involving average, healthy subjects. An additional factor of 10 may also be used for each of the following condition:

- extrapolation from chronic animal studies to humans
- extrapolation from a LOAEL to a NOAEL
- extrapolation from subchronic to chronic studies

Finally, based on the level of certainty of the study and database, an additional modifying factor (between zero and ten) may be used. In establishing an RfD, the EPA assigns it a level of confidence: low, medium, or high.

The toxicity criteria for non-carcinogenic effects associated with oral exposures is summarized in Table 4-2. For each COPC, these tables contain the available RfD, EPA's confidence level in the RfD, the critical effect, the source of the RfD, and the uncertainty and modifying factors used in setting the RfD. In the absence of non-cancer toxicity values for a constituent, values for a structurally related constituent are used if available.

Special Note: The shellfish tissue and sediment samples analyzed for PCB congeners were reported by the laboratory specific to the PCB congener and were not reported by Aroclor. Aroclor-1254 is the most common non-carcinogenic Aroclor found at industrial sites such as this one. The PCB Sum of the Congeners (See Section 2.3.3 for explanation of reported values) value is approximately equal to the amount of total Aroclor in each sample, therefore, the PCB sum of the congeners will be carried through the risk assessment for non-cancer risk and assumed to all be Aroclor-1254. This represents a conservative approach for noncarcinogenic risk for PCB exposure, and likely overestimates the noncarcinogenic risk at the site.

4.3 CONSTITUENTS FOR WHICH EPA HAS NOT DEVELOPED TOXICITY CRITERIA

4.3.1 Shellfish

The COPCs for which EPA (1993a, 1994a) has not developed toxicity values are excluded from the quantitative risk characterization. These COPCs include lead, eight PAHs (acenaphthylene; benzo(e)pyrene; benzo(g,h,i)perylene; 2,6-dimethylnaphthalene; 1-methylphenanthrene; perylene; phenanthrene; and 1,6,7-trimethylnaphthalene) and one SVOCs (dibutyltin). With the exception of lead in shellfish, a qualitative risk evaluation for these COPCs is provided in Section 6.2. For lead in shellfish, the following approach is used.

Since EPA (1993a, 1994a) toxicity values have not been established for lead, an alternative approach for evaluating lead-related risks was used. Specifically, lead in shellfish was assessed using EPA's (Marcus and Cohen, 1988) Integrated Exposure Lead Uptake/Biokinetic (IEUBK) Model (Version 0.99) (EPA, 1994b). The IEUBK model incorporates a variety of lead exposure pathways (ingestion of soil, dust, water, and food; inhalation of dust; maternal contribution) into a series of biologically based equations that transform exposure dosages into blood lead levels for young children. The key risk parameters are the population geometric mean blood lead level and the upper 95 percent bound on this mean. Blood lead is the key dosimeter available to predict risk because human adverse health effects have traditionally been reported in relation to corresponding blood lead levels.

For this assessment of lead in shellfish, default values in the model are used to represent background lead concentrations in air, soil, house dust, water, and the level of material contribution. Additionally, the model's default values are used to represent respiratory rate, soil and water ingestion rates, and the percent of lead absorption by the various exposure routes. The site-specific factors put into the IEUBK Model are lead concentrations in shellfish and the portion of the diet this represents.

The results of the geometric average blood lead level (in micrograms of lead per deciliter of blood; μg/dl) for 0 to 6 year old children and the percentage of this population predicted to fall below and exceed 10 μg/dl are summarized (along with the quantitative cancer risk and non-cancer HI results) in Section 6.1. A blood lead level of 10 μg/dl is used as the criterion value for children 0 to 6 years and is based on the suggestion that neurological and perhaps hematological effects can occur in the vicinity of 10 to 15 μg/dl in children (ATSDR, 1988). Thus, an important parameter of population risk is the percentage of 0 to 6 year old children predicted to have blood lead levels in excess of 10 μg/dl. In this HHRA, greater than 5 percent of 0 to 6 year old children with blood leads in excess of 10 μg/dl is used as the threshold for concern.

Noncarcinogenic risks for adult residents from exposures to lead in shellfish were estimated using the Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil (EPA, 1996a). The model is based on a biokinetic slope factor that estimates fetal blood lead concentrations in women exposed to lead in contaminated media. A simplified (linear) representation of lead biokinetics is used to predict quasi-steady state blood lead concentrations among adults who have relatively steady patterns of lead exposure. The intake assumptions used

in the model were the maximum (RME) and the average (CTE) lead concentrations in shellfish at the site, a shellfish ingestion rate, and an exposure frequency.

4.3.2 Sediment

The COPCs for which EPA (1993a, 1994a) has not developed toxicity values are excluded from the quantitative risk characterization. These COPCs include lead, eight PAHs (acenaphthylene; benzo(e)pyrene; benzo(g,h,i)perylene; 2,6-dimethylnaphthalene; 1-methylphenanthrene; perylene; phenanthrene; and 1,6,7-trimethylnaphthalene) and three SVOCs (dibutyltin, monobutyltin, and tetrabutyltin). A qualitative risk evaluation for these COPCs is provided in Section 6.2.

5.0 EXPOSURE ASSESSMENT

This section of the HHRA identifies the exposure scenarios and pathways of interest, calculates the EPCs for the media of interest, and estimates the exposure for each pathway and scenario combination.

5.1 SELECTION OF EXPOSURE SCENARIOS AND PATHWAYS

Exposure scenarios for this HHRA were selected on the basis of the current and future anticipated uses of the site, an aim toward addressing all of the key human exposure media, and on discussions with EPA (1994c). Future human exposure to constituents in shellfish caught in off-shore locations close to the site may be possible through ingestion. No shore or near shore sediment exposure is anticipated at the site, however, a beach area south of the site has recently been rehabilitated. Its proximity to the site indicates that there is a possibility that the beach area may have been impacted by site activities and the presence of the beach allows the possibility for trespassers to access it. No sediment samples have been collected at the beach, however, in order to evaluate sediment exposure to trespassers at the beach, a sediment sample from Coddington Cove will be used to estimate the concentrations of constituents at the beach area. Consequently, the exposure scenarios in this HHRA include future ingestion of shellfish by adult residents, child residents, and subsistent fishermen and current ingestion of and dermal contact with sediment by child and adult trespassers. These scenarios are described below:

Scenario 1 (Future Shellfish Ingestion by Adults)

Exposures of adults living near the site through the ingestion of shellfish (i.e., hard shell clams, blue mussels, and lobsters) are considered in this scenario.

Scenario 2 (Future Shellfish Ingestion by Children)

Exposures of children living near the site through the ingestion of shellfish (hard shell clams, blue mussels, and lobsters) are considered in this scenario.

Scenario 3 (Future Shellfishing by Subsistent Fishermen)

Exposures of subsistent fishermen through the ingestion of shellfish (hard shell clams, blue mussels, and lobsters) are considered in this scenario.

Scenario 4 (Current Child Trespassers)

Exposures of trespassing children ages 0-6 through ingestion and dermal contact with sediments during swimming, wading and shellfishing are considered in this scenario.

Scenario 5 (Current Adult Trespassers)

Exposures of trespassing adults through ingestion and dermal contact with sediments during swimming, wading and shellfishing are considered in this scenario.

Each scenario includes a particular potential "receptor population" and a consideration of the pathways by which those receptors may encounter site media and COPCs. The selected exposure pathways for each scenario are not intended to encompass all possible routes of exposure but rather to focus on those that are likely to contribute the greatest exposure for each identified receptor.

5.2 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

5.2.1 Shellfish Tissue Exposure Point Concentrations

As specified in the EPA Region I guidance (EPA, 1989a), two types of EPCs (the mean and the maximum detected concentrations) are identified for each COPC detected in shellfish tissue collected at the site.

For the purposes of the HHRA, the arithmetic mean, rather than the geometric mean, is used as the indicator of the central tendency (CTE) of the site data. Although it is reasonable to assume most environmental sampling data are log-normal (see, for example, EPA's (1992c) Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS): Calculating the Concentration Term), the arithmetic mean is used in the HHRA (consistent with verbal guidance from EPA

Region I (1994b)). The arithmetic mean is calculated as follows:

$$Xij_{bar} = \frac{(Xi_1 + Xi_2 + ...Xi_n)}{n}$$

where:

Xij_{bar}	=	arithmetic mean of all sample concentrations of constituent i in medium j
Xi	=	the concentration for constituent i in each of n samples
n	=	the number of samples

The maximum detected concentration is also used to assess potential exposures and risks. Exposure estimates based on maximum concentrations are referred to by EPA Region I (1989a) as estimates of reasonable maximum exposure (RME). This definition of RME differs from the one provided in RAGS (EPA, 1989b), which defines RME as the highest exposure that is reasonably expected to occur at a site. In RAGS, the 95 percent upper confidence limit (UCL) on the mean (not the maximum detected concentration) is used as the RME EPC. Use of the maximum concentration is a worst-case approach, which assumes each receptor only comes in contact with the maximum concentration in the media of interest and likely overstates the potential risks. The site-specific data used to determine the arithmetic means and maximum concentrations of constituents in shellfish are provided in Appendix A.

For assessing potential exposures and risks to chromium in shellfish, this HHRA conservatively assumes that the concentrations reported as total chromium are entirely chromium VI, the more toxic of the two chromium species.

As indicated in the data evaluation discussion (Section 2.3), non-detected values are included in the calculation of EPCs either as one-half the SQL or as the SQL itself. These non-detected values include detection limits associated with a "U" or "UJ" qualifier. For each COPC in each medium, non-detected values are evaluated in light of the range of SQLs and the range of detected concentrations ("hits"). A non-detected value is assigned a value equal to the SQL if the constituent is likely to be present at concentrations equal to or above the SQL. A value equal to one-half the SQL is assigned if the data indicate the constituent is present at concentrations below the SQL (EPA, 1989a,b). Sample and duplicate concentrations are averaged in calculating EPCs.

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (EPA, 1989a; EPA, 1991a; EPA, 1996). Two types of exposure scenarios are considered in this HHRA: reasonable maximum exposure (RME) and central tendency exposure (CTE). RME incorporates plausible but conservative input parameters into the exposure scenarios that are protective of nearly the entire exposed population excluding less than 5 or 10 percent of the population with abnormally high intake rates, whereas CTE incorporates input parameters that are representative of an average exposure scenario.

Table 5-1, Table 5-2, and Table 5-3 provide the hard shell clams, blue mussels, and lobster EPCs as used in Scenario 1 (future adult resident shellfish ingestion), Scenario 2 (future child resident shellfish ingestion), and Scenario 3 (future subsistent fishermen shellfish ingestion), respectively.

5.2.2 Sediment Exposure Point Concentrations

For sediment exposure, only one sample was used for risk estimation, therefore, the EPC for each constituent detected in sediment is equal to its detected concentration in the sediment sample DSY-29-S. Sediment sample DSY-29-S was selected because it has some of the highest detected concentrations of constituents in sediments tested, and because it is one of the closest sample stations to the beach area where the exposure could occur (approximately 500 feet north of the beach). Exposure estimates based on concentrations detected at this station can be considered maximums and are referred to by EPA Region I (1989a) as estimates of reasonable maximum exposure (RME). Use of these maximum concentrations is a worst-case approach, which assumes each receptor only comes in contact with the maximum concentration in the media of interest and likely overstates the potential risks.

For assessing potential exposures and risks to chromium in sediment, this HHRA conservatively assumes that the concentrations reported as total chromium are entirely chromium VI, the more toxic of the two chromium species.

Table 5-4 provides the sediment EPCs as used in Scenario 4 (current child trespasser) and Scenario 5 (current adult trespasser). These receptors are termed trespassers because access to the water in this area for swimming, wading, and shellfishing is not allowed and the area is consistently patrolled by the NETC police.

TABLE 5-1
EXPOSURE POINT CONCENTRATIONS - RME AND CTE - HARD CLAMS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Exposure Point Concentration RME	Exposure Point Concentration CTE
aluminum	14.1624	9.772
arsenic	1.3104	0.945
cadmium	0.126	0.09828
chromium	0.3444	0.2772
copper	2.0132	1.47
iron	35.9408	23.1
manganese	2.7902	1.918
mercury	0.023464	0.01904
nickel	0.5586	0.2296
silver	0.1932	0.04186
zinc	18.3876	14.42
acenaphthene	0.914564	0.3906
anthracene	4.250022	2.324
benz(a)anthracene	18.6032	7.56
benzo(a)pyrene	6.298936	3.304
benzo(b,j,k)fluoranthene	18.035	7.112
chrysene	9.4318	5.04
fluoranthene	25.004756	12.334
fluorene	1.11321	0.4984
indeno(1,2,3-cd)pyrene	3.761744	1.1186
pyrene	27.601056	12.642
PCB 101 (2 2'3 5 5')	3.0289	1.834
PCB 105 (2 3 3'4 4')	34.219528	4.564
PCB 118 (2 3'4 4'5)	2.581096	1.582
PCB 128 (2 2'3 3'4 4')	0.915642	0.518
PCB 138 (2 2'3 4 4'5)	6.621356	4.004
PCB 153 (2 2'4 4'5 5')	7.864682	5.572
PCB 170 (2 2'3 3'4 4'5)	1.568882	0.9282
PCB 18 (2 2'5)	0.42161	0.2548
PCB 180 (2 2'3 4 4'5 5')	3.66338	2.492
PCB 187 (2 2'3 4'5 5'6)	2.872072	2.03
PCB 195 (2 2'3 3'4 4'5 6)	0.567336	0.3052
PCB 206 (2 2'3 3'4 4'5 5'6)	1.131102	0.8316
PCB 209 (2 2'3 3'4 4'5 5'6 6')	1.380484	0.7266
PCB 28 (2 4 4')	3.372292	1.2684
PCB 44 (2 2'3 5')	1.65011	0.4774
PCB 52 (2 2'5 5)	1.626184	0.8638
PCB 66 (2 3'4 4')	3.124912	1.652
PCB Sum of Congeners*	66.536	29.68
hexachlorobenzene	0.39522	0.11466
mirex	0.148778	0.08092
o,p'-DDE	0.536256	0.168
p,p'-DDE	0.664902	0.413
tributyltin	9.3996	6.482

Inorganics are in mg/kg, Organics are in ug/kg, wet weight
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
* = PCB Sum of the Congeners Exposure Point Concentrations are used to estimate Noncarcinogenic Risks as Aroclor-1254 as Aroclor-1254

TABLE 5-2
EXPOSURE POINT CONCENTRATIONS - RME AND CTE - BLUE MUSSELS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Exposure Point Concentration RME	Exposure Point Concentration CTE
aluminum	52.1668	20.16
arsenic	1.7584	1.015
cadmium	0.2604	0.12152
chromium	0.441	0.3724
copper	2.086	1.0738
iron	61.2066	37.1
lead	0.8134	0.2282
manganese	5.3648	2.338
mercury	0.039088	0.02422
nickel	0.7616	0.3136
zinc	19.9178	15.12
1-methylnaphthalene	2.081548	0.6776
2-methylnaphthalene	3.930346	1.204
acenaphthene	2.19268	0.4368
acenaphthylene	12.531904	5.404
anthracene	33.190906	13.342
benz(a)anthracene	145.61148	31.22
benzo(a)pyrene	76.726482	14
benzo(g,h,i)perylene	20.665694	4.746
benzo(b,j,k)fluoranthene	323.4	63.28
1,1-biphenyl	1.805272	0.728
chrysene	87.612014	25.2
dibenz(a,h)anthracene	6.954248	1.2656
fluoranthene	183.4	67.06
fluorene	5.480636	2.898
indeno(1,2,3-cd)pyrene	16.929542	3.724
phenanthrene	38.147088	16.1
pyrene	145.6	49.56
PCB 101 (2 2'3 5 5')	7.94962	5.432
PCB 105 (2 3 3'4 4')	1.3489	0.9156
PCB 118 (2 3'4 4'5)	6.236454	4.046
PCB 128 (2 2'3 3'4 4')	3.220644	2.324
PCB 138 (2 2'3 4 4'5)	17.610152	11.844
PCB 153 (2 2'4 4'5 5')	24.198342	16.8
PCB 170 (2 2'3 3'4 4'5)	0.66073	0.4564
PCB 18 (2 2'5)	0.874412	0.3486
PCB 180 (2 2'3 4 4'5 5')	3.865484	2.184
PCB 187 (2 2'3 4'5 5'6)	7.802774	5.544
PCB 195 (2 2'3 3'4 4'5 6)	0.41608	0.1526
PCB 206 (2 2'3 3'4 4'5 5'6)	0.767886	0.4466
PCB 209 (2 2'3 3'4 4'5 5'6 6')	1.162056	0.5152
PCB 28 (2 4 4')	2.293914	1.456
PCB 44 (2 2'3 5')	1.547308	1.022
PCB 52 (2 2'5 5)	3.059574	2.198
PCB 66 (2 3'4 4')	0.576996	0.308
PCB 8 (2 4)	1.049426	0.5866
PCB Sum of Congeners*	80.4002	56.28
mirex	0.516796	0.3304
o,p'-DDE	1.252986	0.7644
p,p'-DDE	1.700958	1.2278
naphthalene	25.638774	7.854
dibutyltin	5.7232	0.8988
tributyltin	136.7814	20.3

Inorganics are in mg/kg, Organics are in ug/kg, wet weight

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

* = PCB Sum of the Congeners Exposure Point Concentrations are used to estimate Noncarcinogenic Risks as Aroclor-1254

TABLE 5-3
EXPOSURE POINT CONCENTRATIONS - RME AND CTE - LOBSTER
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Exposure Point Concentration RME	Exposure Point Concentration CTE
aluminum	4.35456	0.7098
arsenic	4.0096	3.108
cadmium	0.0784	0.0455
chromium	0.3024	0.266
copper	27.5646	17.78
iron	11.4296	5.558
manganese	0.6356	0.406
mercury	0.06356	0.04494
nickel	0.2632	0.2086
silver	0.9618	0.6636
zinc	23.996	16.8
1-methylnaphthalene	1.856442	0.9688
2-methylnaphthalene	2.083774	1.253
acenaphthene	4.555992	0.6706
anthracene	1.148714	0.5824
benz(a)anthracene	4.060714	1.0122
benzo(a)pyrene	4.021598	1.2068
benzo(b,j,k)fluoranthene	8.5345	3.248
1,1-biphenyl	1.9929	0.658
chrysene	5.402124	1.365
fluoranthene	14.06818	6.664
fluorene	2.088296	0.3528
indeno(1,2,3-cd)pyrene	1.47945	0.3822
pyrene	17.302404	7.98
PCB 101 (2 2'3 5 5')	5.23306	1.764
PCB 105 (2 3 3'4 4')	29.20855	6.342
PCB 118 (2 3'4 4'5)	9.650522	4.41
PCB 128 (2 2'3 3'4 4')	1.734278	0.7546
PCB 138 (2 2'3 4 4'5)	9.965172	5.222
PCB 153 (2 2'4 4'5 5')	13.87477	7.392
PCB 170 (2 2'3 3'4 4'5)	1.71143	1.001
PCB 18 (2 2'5)	1.501584	0.441
PCB 180 (2 2'3 4 4'5 5')	4.793432	2.394
PCB 187 (2 2'3 4'5 5'6)	4.409538	2.212
PCB 195 (2 2'3 3'4 4'5 6)	0.656516	0.413
PCB 206 (2 2'3 3'4 4'5 5'6)	1.00989	0.7714
PCB 209 (2 2'3 3'4 4'5 5'6 6')	0.809424	0.5908
PCB 28 (2 4 4')	5.711846	1.3314
PCB 44 (2 2'3 5')	1.21184	0.658
PCB 52 (2 2'5 5)	1.83351	1.1914
PCB 66 (2 3'4 4')	2.715174	1.736
PCB 8 (2 4)	1.019844	0.3654
PCB Sum of Congeners*	60.238	38.78
hexachlorobenzene	0.175952	0.10948
mirex	0.21665	0.11396
o,p'-DDE	0.99239	0.1736
p,p'-DDE	1.37137	0.8624
naphthalene	4.928602	1.624

Inorganics are in mg/kg, Organics are in ug/kg, wet weight

TABLE 5-4
EXPOSURE POINT CONCENTRATIONS - SEDIMENT SAMPLE DSY-29-S
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Substance	Exposure Point Concentration
aluminum	37147.5
arsenic	12.46
cadmium	1.45
chromium	86.5
copper	157.75
iron	35452.5
lead	185.9
manganese	282.25
mercury	0.5
nickel	34.75
silver	0.79
zinc	392.75
1,6,7-trimethylnaphthalene	27.94
1-methylnaphthalene	50.07
1-methylphenanthrene	266.56
2,6-dimethylnaphthalene	112.32
2-methylnaphahalene	73.47
acenaphthene	188.59
acenaphthylene	300.15
anthracene	1220
benz(a)anthracene	2700
benzo(a)pyrene	2380
benzo(b,j,k)fluoranthene	5350
benzo(e)pyrene	1950
benzo(g,h,i)perylene	1110
1,1-biphenyl	29.91
chrysene	2800
dibenz(a,h)anthracene	317.43
fluoranthene	4970
fluorene	293.64
indeno(1,2,3-cd)pyrene	1020
naphthalene	76.08
perylene	610.95
phenanthrene	1609.54
pyrene	5300
PCB 101 (2 2'3 5 5')	16.7
PCB 105 (2 3 3'4 4')	6.61
PCB 118 (2 3'4 4'5)	18.38
PCB 128 (2 2'3 3'4 4')	5.14
PCB 138 (2 2'3 4 4'5)	27.04
PCB 153 (2 2'4 4'5 5')	22.8
PCB 170 (2 2'3 3'4 4'5)	7.25
PCB 18 (2 2'5)	0.68
PCB 180 (2 2'3 4 4'5 5')	13.79
PCB 187 (2 2'3 4'5 5'6)	8.54
PCB 195 (2 2'3 3'4 4'5 6)	3.83
PCB 206 (2 2'3 3'4 4'5 5'6)	17.39
PCB 209 (2 2'3 3'4 4'5 5'6 6')	105.27
PCB 28 (2 4 4')	1.66
PCB 44 (2 2'3 5')	3.94
PCB 52 (2 2'5 5)	9.69
PCB 66 (2 3'4 4')	3.87
PCB 8 (2,4)	0.6
PCB Sum of Congeners*	273.19
aldrin	0.1
hexachlorobenzene	0.16
mirex	0.1
o,p'-DDE	4.96
p,p'-DDE	6.29
dibutyltin	20.58
monobutyltin	8.65
tetrabutyltin	0.5
tributyltin	60.89

Inorganics are in mg/kg, Organics are in ug/kg, dry weight

* = PCB Sum of the Congeners Exposure Point Concentrations are used to estimate Noncarcinogenic Risks as Aroclor-1254

5.3 ESTIMATION OF EXPOSURE

5.3.1 Shellfish Exposure

The estimation of shellfish ingestion exposure for RME and CTE scenarios for each pathway combination are calculated using the equation listed below:

$$IngestionDose(mg/kg/day) = \frac{Conc * IngRate * FI * CF * EF * ED}{BW * AT}$$

where:

Conc = Exposure point concentration (either the arithmetic mean or the maximum detected concentration; mg/kg for shellfish tissue)

IngRate = Ingestion rate (mg/day)

FI = Fraction ingested from contaminated source (unitless)

CF = Conversion Factor (1E-06 kg/mg)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time (for carcinogens <365 d/yr * 70 yr = 25,550 days>; for Noncarcinogens <365 d/yr * ED>)

The constituent exposure dose for each pathway in each of the scenarios is based on numerous parameters with varying degrees of uncertainty. The exposure parameters used in calculating the constituent doses and the rationale for selecting them are summarized in Table 5-5.

A detailed description of the shellfish exposure scenarios and exposure parameters for the anticipated future exposure scenarios follow:

- Future adult resident (future shellfishing scenario) - For this scenario, adult residents are assumed to be exposed to chemicals in shellfish (mussels, clams, and lobsters) obtained from near-shore and off-shore locations near the former Derecktor Shipyard through ingestion. Standard EPA (1993) assumptions for exposure frequency and duration under residential land use are used (350 days/year, 30 years). The shellfish ingestion rates are 1,200 mg/day for

TABLE 5-5
EXPOSURE PARAMETERS - INGESTION OF SHELLFISH
HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Receptor	Future Adult Resident	Future Child Resident	Future Subsistent Fisherman
Concentration	Chemical Specific (mg/kg)	Chemical Specific (mg/kg)	Chemical Specific (mg/kg)
Ingestion Rate	1,200 mg/day = 150,000 mg seafood per serving and 2.9 servings per year (NPD, nd)[1]	396 mg/day = 48,000 mg seafood per serving and 2.9 servings per year (NPD, nd) [1]	15,600 mg/d = 150000 mg seafood per serving and 36.5 servings per year (NPD, nd) [1]
Fraction Ingested	100% - Maximum Estimate	100% - Maximum Estimate	100% - Maximum Estimate
Exposure Frequency	350 days/year - assumes 2 weeks vacation per year (EPA 1993)	350 days/year - assumes 2 weeks vacation per year (EPA 1993)	350 days/year - assumes 2 weeks vacation per year (EPA 1993)
Exposure Duration	30 years - 90 th percentile for time spent in one residence (EPA 1993)	6 years - Duration of exposure for child age 0 - 6	30 years - 90 th percentile for time spent in one residence (EPA 1993)
Body Weight	70 kg - Average of males and females 18 - 65 (EPA 1993)	15 kg - Average of males and females 0 - 6 (EPA 1993)	70 kg - Average of males and females 18 - 65 (EPA 1993)
Averaging Time (carc)	25,550 days - based on 70 year exposure to carcinogens (EPA 1989)	25,550 days - based on 70 year exposure to carcinogens (EPA 1989)	25,550 days - based on 70 year exposure to carcinogens (EPA 1989)
Averaging Time (noncar)	10,950 days - based on exposure duration (EPA 1989)	2,190 days - based on exposure duration (EPA 1989)	10,950 days - based on exposure duration (EPA 1989)

[1] Refer to text and Appendix E

shellfish tissue and are based on an estimate of seafood serving sizes (150,000 mg/meal) and Rhode Island survey data on the number of hard-shell clam meals eaten per year (2.9 meals/year) provided by RIDEM (Narragansett Bay Project, n.d.). The reader is also referred to Appendix E. This receptor will be evaluated for eating mussels, clams, and lobster separately.

- Future child resident (future shellfishing scenario) - For this scenario, child residents are assumed to be exposed to chemicals in shellfish (mussels, clams, and lobsters) obtained from near-shore and off-shore locations near the former Derecktor Shipyard through ingestion. Standard EPA (1993) assumptions for exposure frequency and duration under residential land use are used (350 days/year, 6 years). The shellfish ingestion rates are 396 mg/day for shellfish tissue and are based on an estimate of seafood serving sizes (48,000 mg/meal or 32 percent of the adult meal) and Rhode Island survey data on the number of hard-shell clam meals eaten per year (2.9 meals/year) provided by RIDEM (Narragansett Bay Project, n.d.). Child shellfish ingestion rates are not available from either EPA or RIDEM. In order to estimate the child ingestion rates, the ratios of child versus adult seafood ingestion rates from these documents are 26 percent (Rupp, 1980), 33 percent (EPA 1989b), and 38 percent (EPA, 1991a). The resulting average, 32 percent, is considered conservative and appropriate. Applying this average to the ingestion rates for adults yields an average meal size of 48,000 mg/meal for children, rather than the 150,000 mg/meal consumed by adults (refer also to Appendix E). This receptor will be evaluated for eating mussels, clams, and lobster separately.

- Future subsistent fisherman (future subsistent fishing scenario) - For this scenario, adult subsistent fisherman are assumed to be exposed to chemicals in shellfish (mussels, clams, and lobsters) obtained from near-shore and off-shore locations near the former Derecktor Shipyard through ingestion. Standard EPA (1993) assumptions for exposure frequency and duration under residential land use are used (350 days/year, 30 years). The shellfish ingestion rates are 15,600 mg/day for shellfish tissue and are based on an estimate of seafood serving sizes (150,000 mg/meal) and Rhode Island survey data on the number of hard-shell clam meals eaten per year (36.5 meals/year) provided by RIDEM (refer also to Appendix E). This receptor will be evaluated for eating mussels, clams, and lobster separately.

For the assessment of ingestion of lead in shellfish by residential children, default values in the model are used to represent background lead concentrations in air, soil, house dust, water, and the level of material contribution. Additionally, the model's default values are used to represent respiratory rate, soil and water ingestion rates, and the percent of lead absorption by the various

exposure routes. The site-specific factors put into the IEUBK Model are the maximum (RME) and the average (CTE) lead concentrations in shellfish and the portion of the diet this represents.

Noncarcinogenic risks for adult residents from exposures to lead in shellfish were estimated using the Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil (EPA, 1996). The model is based on a biokinetic slope factor that estimates fetal blood lead concentration in women exposed to lead in contaminated media. A simplified (linear) representation of lead biokinetics is used to predict quasi-steady state blood lead concentrations among adults who have relatively steady patterns of lead exposure. The intake assumptions used in the model are the maximum (RME) and the average (CTE) lead concentrations in shellfish at the site, a shellfish ingestion rate, and a exposure frequency.

5.3.2 Sediment Exposure

The estimation of sediment ingestion exposure for the RME scenario for each pathway are calculated using the equation listed below:

$$IngestionDose(mg/kg/day) = \frac{Conc * IngRate * FI * CF * EF * ED}{BW * AT}$$

where:

Conc = Exposure point concentration (the maximum detected concentration in sediment; (mg/kg)

IngRate = Ingestion rate (mg/day)

FI = Fraction ingested from contaminated source (unitless)

CF = Conversion Factor (1E-06 kg/mg)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time (for carcinogens <365 d/yr * 70 yr = 25,550 days>; for noncarcinogens <365 d/yr * ED>)

The estimation of sediment dermal contact exposure for the RME scenario for each pathway are calculated using the equation listed below:

Sediment Dermal Contact Exposure For Adults:

$$DermalDose(mg/kg/day) = \frac{DA_{event} * SA * EV * EF * ED}{BW * AT}$$

$$DA_{event} = Conc * AF * ABS_{dermal} * CF$$

Sediment Dermal Contact Exposure For Children:

$$DermalDose(mg/kg/day) = \frac{DA_{event} * EF * EV}{AT} * AgeAdj$$

$$AgeAdj = \sum_{i=m}^{n} \frac{SA_i * ED_i}{BW_i}$$

$$DA_{event} = Conc * AF * ABS_{dermal} * CF$$

where:

DA_{event} = Dose absorbed per unit area per event (mg/cm^2-event)

SA = Skin surface area available for contact (cm^2/event)

EV = Event Frequency (events/year)

EF = Exposure frequency (events/year)

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Averaging time (for carcinogens <365 d/yr * 70 yr = 25,550 days>; for noncarcinogens <365 d/yr * ED>)

Conc = Exposure point concentration (the maximum detected concentration in sediment; (mg/kg)

AF = Soil to skin adherence factor (mg/cm^2)

ABS_{derma} = Absorption fraction (unitless)

CF = Conversion factor (1×10^{-6} kg/mg for inorganics; 1×10^{-9} kg/μg for organics)

AgeAdj = Age Adjusted Surface Area (cm^2-yr/kg)

SA_i = Surface area exposed at age i (cm^2)

ED_i = Exposure duration at age i (years)

BW_i = Body weight at age i (kg)

The constituent exposure dose for each pathway in each of the scenarios is based on numerous parameters with varying degrees of uncertainty. The exposure parameters used in calculating the constituent doses and the rationale for selecting them are summarized in Table 5-6 (ingestion of sediment) and Table 5-7 (dermal contact with sediment).

A detailed description of the sediment exposure scenarios and exposure parameters for the anticipated current exposure scenarios follows:

- Current child resident (current trespasser scenario) - For this scenario, children ages 0 through 6 years are assumed to trespass to the site 7 days per year for swimming, wading, and shellfishing during the summer season. Children ages 0 through 6 are selected as a sensitive population. Children are assumed to trespass to the site every year for an exposure duration of 6 years. Exposure to site constituents is based on current conditions and assumed to occur through the incidental ingestion of and dermal contact with shoreline/near-shore sediment.

- Current adult resident (current trespasser scenario) - For this scenario, it is assumed that adults are assumed trespass to the site for swimming, wading, and shellfishing 7 days per year during the summer season. An exposure frequency of 7 days is selected as the national average number of days of swimming per year (EPA, 1989b). Adults are assumed to trespass to the site every year for an exposure duration of 30 years. Exposure to site constituents is based on current (pre-remediation) conditions and assumed to occur through the incidental ingestion of and dermal contact with shoreline/near-shore sediment.

TABLE 5-6
EXPOSURE PARAMETERS - INGESTION OF SEDIMENT (TRESPASSER SCENARIO)
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Receptor	Current Child Trespasser	Current Adult Trespasser
Concentration	Chemical Specific (mg/kg)	Chemical Specific (mg/kg)
Ingestion Rate	400 mg/day - Upperbound value for noncontact intensive scenarios (EPA, 1995; EPA/600/P-95/002Fa)	100 mg/day - Upperbound value for noncontact intensive scenarios (EPA, 1993)
Fraction Ingested	100% - Maximum Estimate	100% - Maximum Estimate
Relative Absorption Factor	VOCs - 100%; SVOCs - 100%; Pesticides - 100%; PCBs - 30%; Inorganics - 100%	VOCs - 100%; SVOCs - 100%; Pesticides - 100%; PCBs - 30%; Inorganics - 100%
Exposure Frequency	7 days/year - national average number of days swimming per year (EPA 1989a)	7 days/year - national average number of days swimming per year (EPA 1989a)
Exposure Duration	6 years - Duration of exposure for child age 0 - 6	30 years - 90 th percentile for time spent in one residence (EPA 1993)
Body Weight	15 kg - Average of males and females 0 - 6 (EPA 1993)	70 kg - Average of males and females 18 - 65 (EPA 1993)
Averaging Time (carc)	25,550 days - based on 70 year exposure to carcinogens (EPA 1989)	25,550 days - based on 70 year exposure to carcinogens (EPA 1989)
Averaging Time (noncar)	2,190 days - based on exposure duration (EPA 1989)	10,950 days - based on exposure duration (EPA 1989)

TABLE 5-7
EXPOSURE PARAMETERS - DERMAL CONTACT WITH SEDIMENT (TRESPASSER SCENARIO)
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Receptor	Current Child Recreational Visitor	Current Adult Recreational Visitor
Concentration	Chemical Specific (mg/kg)	Chemical Specific (mg/kg)
Skin Surface Area Available for Contact	Represented by Age Adjusted Surface Area; See Below	2000 cm^2 - Trespasser activities (hands and feet) (EPA, 1989)
Adherence Factor	0.5 mg/cm^2 - Based on Region 1 review of soil adherence to hands	0.5 mg/cm^2 - Based on Region 1 review of soil adherence to hands
Absorption Factor	PCBs - 6%; Cadmium - 1%	PCBs - 6%; Cadmium - 1%
Exposure Frequency	7 days/year - national average number of days swimming per year (EPA 1989a)	7 days/year - national average number of days swimming per year (EPA 1989a)
Exposure Duration	6 years - Duration of exposure for child age 0 - 6	30 years - 90 th percentile for time spent in one residence (EPA 1993)
Body Weight	Represented by Age Adjusted Body Weight ; See Below	70 kg - Average of males and females 18 - 65 (EPA 1993)
Age Adjusted Surface Area	1390 cm^2-year/kg (Trespasser activities, represents hands, arms, legs, and feet); See Appendix F for derivation of value.	Not Applicable
Averaging Time (carc)	25,550 days - based on 70 year exposure to carcinogens (EPA 1989)	25,550 days - based on 70 year exposure to carcinogens (EPA 1989)
Averaging Time (noncar)	2,190 days - based on exposure duration (EPA 1989)	10,950 days - based on exposure duration (EPA 1989)

6.0 RISK CHARACTERIZATION

This section of the HHRA provides an estimation of the quantitative carcinogenic and noncarcinogenic risks and a qualitative discussion of the exclusion of chemicals that lack quantitative toxicity values. Risk characterization takes into account hazard identification (Section 2.0), toxicity assessment (Section 4.0), and exposure assessment (Section 5.0) to estimate risks for the site.

6.1 QUANTITATIVE RISK ASSESSMENT

The results of the quantitative risk analysis are presented in two forms carcinogenic and noncarcinogenic risks.

In the case of human health effects associated with exposure to potential carcinogens, estimates of cancer risk are expressed as the lifetime probability of additional cancer risk associated with the given exposure. The cancer risks are calculated as the cancer-based exposure dose (mg/kg-d) times the slope factor ((mg/kg-d)$^{-1}$). In numerical terms, the cancer risks are presented in scientific notation in this report. Thus, an estimated cancer risk of 1E-04 means an excess incremental lifetime cancer risk of one in ten thousand; an estimated cancer risk of 1E-06 means an excess incremental lifetime cancer risk of one in one million and so on.

Incremental cancer risk estimates are generated for each of the exposure pathways using the estimated doses and published SFs, as follows:

$$Risk = Intake * SF$$

If the above equation results in a risk greater than 0.01, the following equation is used:

$$Risk = 1 - e^{-(Intake*SF)}$$

The hazard quotient (HQ) is used to determine whether non-cancer health effects may be a concern. The HQ is calculated as the non-cancer exposure dose (mg/kg-d) divided by the RfD (mg/kg-d). Chronic RfDs are used for those scenarios involving long-term exposures (trespassing,

ingestion of shellfish). The HQs are summed across constituents to calculate a hazard index (HI) for each pathway in each scenario. The HQs (and HIs) are also presented in scientific notation in this report, where an HQ of 5E-01 means the estimated exposure dose is one-half the RfD.

Noncarcinogenic risk is assessed using the concept of HQs and HIs. The HQ is the ratio of the estimated dose and the RfD for a selected chemical of concern, as follows:

$$HQ = \frac{Intake}{RfD}$$

The estimated cancer risks and non-cancer HIs are discussed below for the shellfish ingestion scenarios. These cancer risks and non-cancer HIs are compared to available regulatory guidelines. Under Superfund (EPA, 1990b), a risk range of 1E-06 to 1E-04 is generally acceptable, while risks above 1E-04 imply a possible need for remediation. Regarding non-carcinogenic health hazards, EPA (1989b) states that, "When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Thus, the estimated cancer risks that are identified in the HHRA as posing a potential concern are those greater than 1E-06 for individual COPCs and 1E-04 to 1E-06 for pathway risks, and for non-cancer HIs, those greater than 1E+00.

The estimated total cancer risks and non-cancer HIs for all of the exposure scenarios are provided in Table 6-1. The estimated chemical-specific cancer risks and non-cancer HIs for all of the exposure scenarios are provided in Tables 6-2 through 6-17. Note that cancer risks (constituent-specific and pathway-specific) above 1E-06 and HQs above 1E+00 are presented in bold on Table 6-1 through Table 6-17. The estimated cancer risks and non-cancer HIs are presented in the following text as a range in which both the CTE value (based on the arithmetic mean concentrations; applicable only for the shellfish ingestion exposure scenarios) and the RME value (based on the maximum detected concentrations) are provided. For COPCs without EPA toxicity values, a qualitative assessment of risk is provided in Section 6.2.

Special Note: As explained in Section 2.3.3, PCBs in shellfish and sediment were reported in the data set in three ways; 1) Common Congeners, 2) PCB Sum of the Congeners, and 3) PCB Sum of the Congeners x 2. The carcinogenic risks for PCBs shown on the tables in this section are

TABLE 6-1
SUMMARY OF CANCER RISKS AND HAZARD INDICES
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Scenario	Child Resident		Adult Resident		Subsistence Fisherman		Trespasser Child	Trespasser Adult
	RME	CTE	RME	CTE	RME	CTE	RME	RME
CANCER RISKS								
Ingestion of Hard Shell Clams	**5.1E-06**	**3.4E-06**	**1.6E-05**	**1.1E-05**	**2.0E-04**	**1.4E-04**	NA	NA
Ingestion of Blue Mussels	**1.0E-05**	**4.2E-06**	**2.8E-05**	**1.3E-05**	**3.3E-04**	**1.6E-04**	NA	NA
Ingestion of Lobster	**1.4E-05**	**1.1E-05**	**4.4E-05**	**3.4E-05**	**5.7E-04**	**4.4E-04**	NA	NA
Sediment Ingestion and Dermal Contact	NA	NA	NA	NA	NA	NA	**2.0E-06**	5.5E-07
NONCANCER RISKS								
Ingestion of Hard Shell Clams	2.2E-01	1.4E-01	1.4E-01	8.9E-02	**1.9E+00**	**1.2E+00**	NA	NA
Ingestion of Blue Mussels	4.0E-01	1.9E-01	2.6E-01	1.3E-01	**3.3E+00**	**1.6E+00**	NA	NA
Ingestion of Lobster	4.6E-01	3.4E-01	3.0E-01	2.2E-01	**3.9E+00**	**2.9E+00**	NA	NA
Sediment Ingestion and Dermal Contact	NA	NA	NA	NA	NA	NA	1.3E-01	6.9E-03

Bold Text indicates significant risks (i.e. cancer risk > 1.00E-06 or noncancer hazard index > 1.0)

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

TABLE 6-2

ESTIMATED RME CANCER RISKS - HARD CLAM INGESTION USING EPC = Maximum

MARINE HUMAN HEALTH RISK ASSESSMENT

FORMER DERECKTOR SHIPYARD

NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration*	Substance	Estimated Incremental Cancer Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
14.1624	aluminum	NT	NT	NT
1.3104	**arsenic**	**4.27E-06**	**1.38E-05**	**1.81E-04**
0.126	cadmium	NT	NT	NT
0.3444	chromium	NT	NT	NT
2.0132	copper	NT	NT	NT
35.9408	iron	NT	NT	NT
2.7902	manganese	NT	NT	NT
0.023464	mercury	NT	NT	NT
0.5586	nickel	NT	NT	NT
0.1932	silver	NT	NT	NT
18.3876	zinc	NT	NT	NT
0.914564	acenaphthene	NT	NT	NT
4.250022	anthracene	NT	NT	NT
18.6032	**benz(a)anthracene**	2.94E-08	9.56E-08	**1.24E-06**
6.298936	**benzo(a)pyrene**	9.98E-08	3.23E-07	**4.21E-06**
18.035	**benzo(b,j,k)fluoranthene**	2.85E-08	9.27E-08	**1.21E-06**
9.4318	chrysene	1.50E-10	4.84E-10	6.30E-09
25.004756	fluoranthene	NT	NT	NT
1.11321	fluorene	NT	NT	NT
3.761744	indeno(1,2,3-cd)pyrene	5.96E-09	1.93E-08	2.52E-07
27.601056	pyrene	NT	NT	NT
3.0289	PCB 101 (2 2'3 5 5')	1.31E-08	4.27E-08	5.54E-07
34.219528	**PCB 105 (2 3 3'4 4')**	1.48E-07	4.82E-07	**6.27E-06**
2.581096	PCB 118 (2 3'4 4'5)	1.12E-08	3.64E-08	4.73E-07
0.915642	PCB 128 (2 2'3 3'4 4')	3.98E-09	1.29E-08	1.68E-07
6.621356	**PCB 138 (2 2'3 4 4'5)**	2.87E-08	9.32E-08	**1.21E-06**
7.864682	**PCB 153 (2 2'4 4'5 5')**	3.42E-08	1.11E-07	**1.44E-06**
1.568882	PCB 170 (2 2'3 3'4 4'5)	6.80E-09	2.21E-08	2.87E-07
0.42161	PCB 18 (2 2'5)	1.83E-09	5.94E-09	7.73E-08
3.66338	PCB 180 (2 2'3 4 4'5 5')	1.60E-08	5.17E-08	6.71E-07
2.872072	PCB 187 (2 2'3 4'5 5'6)	1.25E-08	4.05E-08	5.26E-07
0.567336	PCB 195 (2 2'3 3'4 4'5 6)	2.46E-09	7.99E-09	1.04E-07
1.131102	PCB 206 (2 2'3 3'4 4'5 5'6)	4.91E-09	1.60E-08	2.07E-07
1.380484	PCB 209 (2 2'3 3'4 4'5 5'6 6'	5.99E-09	1.95E-08	2.53E-07
3.372292	PCB 28 (2 4 4')	1.47E-08	4.75E-08	6.17E-07
1.65011	PCB 44 (2 2'3 5')	7.17E-09	2.32E-08	3.02E-07
1.626184	PCB 52 (2 2'5 5)	7.06E-09	2.30E-08	2.98E-07
3.124912	PCB 66 (2 3'4 4')	1.36E-08	4.41E-08	5.73E-07
66.5359	**PCB Sum of the Congeners**	3.33E-07	**1.08E-06**	**1.40E-05**
0.39522	hexachlorobenzene	1.37E-09	4.45E-09	5.80E-08
0.148778	mirex	5.81E-10	1.89E-09	2.45E-08
0.536256	o,p'-DDE	3.96E-10	1.28E-09	1.67E-08
0.664902	p,p'-DDE	4.90E-10	1.60E-09	2.07E-08
9.3996	tributyltin	NT	NT	NT
	TOTAL RISK:	**5.09E-06**	**1.58E-05**	**2.01E-04**

Bold Text indicates those chemicals which are significant contributors (i.e. cancer risk > 1.00E-06) to the cancer risk

The cancer risks for PCBs (total) are as follows: Child (6.66E-07), Adult (2.16E-06), and Fisherman (2.80E-05)

EPC = Exposive Point Concentration

NT - Risk not calculated: No toxicity factor available for t'iis compound

*** wet weight**

TABLE 6-3
ESTIMATED CTE CANCER RISKS - HARD CLAMS USING EPC = Average
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration*	Substance	Estimated Incremental Cancer Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
9.772	aluminum	NT	NT	NT
0.945	**arsenic**	**3.08E-06**	**9.98E-06**	**1.30E-04**
0.09828	cadmium	NT	NT	NT
0.2772	chromium	NT	NT	NT
1.47	copper	NT	NT	NT
23.1	iron	NT	NT	NT
1.918	manganese	NT	NT	NT
0.01904	mercury	NT	NT	NT
0.2296	nickel	NT	NT	NT
0.04186	silver	NT	NT	NT
14.42	zinc	NT	NT	NT
0.3906	acenaphthene	NT	NT	NT
2.324	anthracene	NT	NT	NT
7.56	benz(a)anthracene	1.20E-08	3.89E-08	5.05E-07
3.304	**benzo(a)pyrene**	5.24E-08	1.69E-07	**2.21E-06**
7.112	benzo(b,j,k)fluoranthene	1.13E-08	3.66E-08	4.75E-07
5.04	chrysene	7.98E-11	2.59E-10	3.37E-09
12.334	fluoranthene	NT	NT	NT
0.4984	fluorene	NT	NT	NT
1.1186	indeno(1,2,3-cd)pyrene	1.78E-09	5.75E-09	7.48E-08
12.642	pyrene	NT	NT	NT
1.834	PCB 101 (2 2'3 5 5')	7.97E-09	2.59E-08	3.36E-07
4.564	PCB 105 (2 3 3'4 4')	1.97E-08	6.43E-08	8.36E-07
1.582	PCB 118 (2 3'4 4'5)	6.86E-09	2.23E-08	2.90E-07
0.518	PCB 128 (2 2'3 3'4 4')	2.25E-09	7.29E-09	9.49E-08
4.004	PCB 138 (2 2'3 4 4'5)	1.74E-08	5.64E-08	7.34E-07
5.572	**PCB 153 (2 2'4 4'5 5')**	2.42E-08	7.85E-08	**1.02E-06**
0.9282	PCB 170 (2 2'3 3'4 4'5)	4.03E-09	1.31E-08	1.69E-07
0.3906	PCB 18 (2 2'5)	1.69E-09	5.50E-09	7.15E-08
2.492	PCB 180 (2 2'3 4 4'5 5')	1.08E-08	3.51E-08	4.56E-07
2.03	PCB 187 (2 2'3 4'5 5'6)	8.81E-09	2.86E-08	3.72E-07
0.3052	PCB 195 (2 2'3 3'4 4'5 6)	1.32E-09	4.30E-09	5.59E-08
0.8316	PCB 206 (2 2'3 3'4 4'5 5'6)	3.61E-09	1.17E-08	1.53E-07
0.7266	PCB 209 (2 2'3 3'4 4'5 5'6 6')	3.15E-09	1.02E-08	1.33E-07
1.2684	PCB 28 (2 4 4')	5.50E-09	1.79E-08	2.32E-07
0.4774	PCB 44 (2 2'3 5')	2.07E-09	6.72E-09	8.75E-08
0.8638	PCB 52 (2 2'5 5)	3.75E-09	1.22E-08	1.58E-07
1.652	PCB 66 (2 3'4 4')	7.17E-09	2.32E-08	3.02E-07
29.68	**PCB Sum of the Congeners**	1.30E-07	4.23E-07	**5.50E-06**
0.11466	hexachlorobenzene	3.98E-10	1.29E-09	1.68E-08
0.08092	mirex	3.16E-10	1.03E-09	1.33E-08
0.168	o,p'-DDE	1.24E-10	4.02E-10	5.24E-09
0.413	p,p'-DDE	3.05E-10	9.90E-10	1.29E-08
6.482	tributyltin	NT	NT	NT
	TOTAL RISK:	**3.42E-06**	**1.08E-05**	**1.38E-04**

Bold Text indicates those chemicals which are significant contributors (i.e. cancer risk > 1.00E-06) to the cancer risk

The cancer risks for PCBs (total) are as follows: Child (2.60E-07), Adult (8.46E-07), and Fisherman (1.10E-05)

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

*** wet weight**

TABLE 6-4
ESTIMATED RME CANCER RISKS - INDIGENOUS BLUE MUSSELS USING EPC = Maximum
MARINE HUMAN HEALTH RISK ASSESSMENT
DERECKTOR SHIPYARD - OFFSHORE
NEWPORT, RHODE ISLAND

Exposure Point Concentration*	Substance	Estimated Incremental Cancer Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
52.1668	aluminum	NT	NT	NT
1.7584	**arsenic**	**5.73E-06**	**1.86E-05**	**2.42E-04**
0.2604	cadmium	NT	NT	NT
0.441	chromium	NT	NT	NT
2.086	copper	NT	NT	NT
61.2066	iron	NT	NT	NT
5.3648	manganese	NT	NT	NT
0.039088	mercury	NT	NT	NT
0.7616	nickel	NT	NT	NT
19.9178	zinc	NT	NT	NT
2.081548	1-methylnaphthalene	NT	NT	NT
3.930346	2-methylnaphthalene	NT	NT	NT
2.19268	acenaphthene	NT	NT	NT
33.190906	anthracene	NT	NT	NT
145.61148	**benz(a)anthracene**	2.31E-07	7.49E-07	**9.73E-06**
76.726482	**benzo(a)pyrene**	**1.22E-06**	**3.95E-06**	**5.12E-05**
323.4	**benzo(b,j,k)fluoranthene**	**2.25E-06**	**7.30E-06**	**9.48E-05**
1.805272	1,1-biphenyl	NT	NT	NT
87.612014	chrysene	1.39E-09	4.51E-09	5.85E-08
6.954248	**dibenz(a,h)anthracene**	1.10E-07	3.57E-07	**4.65E-06**
183.4	fluoranthene	NT	NT	NT
5.480636	fluorene	NT	NT	NT
16.929542	**indeno(1,2,3-cd)pyrene**	2.69E-08	8.71E-08	**1.13E-06**
145.6	pyrene	NT	NT	NT
7.94962	**PCB 101 (2 2'3 5 5')**	3.44E-08	1.12E-07	**1.46E-06**
1.3489	PCB 105 (2 3 3'4 4')	5.85E-09	1.90E-08	2.46E-07
6.236454	**PCB 118 (2 3'4 4'5)**	2.70E-08	8.79E-08	**1.14E-06**
3.220644	PCB 128 (2 2'3 3'4 4')	1.40E-08	4.54E-08	5.89E-07
17.610152	**PCB 138 (2 2'3 4 4'5)**	7.64E-08	2.48E-07	**3.22E-06**
24.198342	**PCB 153 (2 2'4 4'5 5')**	1.05E-07	3.42E-07	**4.44E-06**
0.66073	PCB 170 (2 2'3 3'4 4'5)	2.87E-09	9.31E-09	1.21E-07
0.874412	PCB 18 (2 2'5)	3.79E-09	1.23E-08	1.60E-07
3.865484	PCB 180 (2 2'3 4 4'5 5')	1.68E-08	5.45E-08	7.08E-07
7.802774	**PCB 187 (2 2'3 4'5 5'6)**	3.39E-08	1.10E-07	**1.43E-06**
0.41608	PCB 195 (2 2'3 3'4 4'5 6)	1.81E-09	5.87E-09	7.62E-08
0.767886	PCB 206 (2 2'3 3'4 4'5 5'6)	3.33E-09	1.08E-08	1.40E-07
1.162056	PCB 209 (2 2'3 3'4 4'5 5'6 6')	5.04E-09	1.64E-08	2.13E-07
2.293914	PCB 28 (2 4 4')	9.95E-09	3.23E-08	4.20E-07
1.547308	PCB 44 (2 2'3 5')	6.72E-09	2.18E-08	2.83E-07
3.059574	PCB 52 (2 2'5 5)	1.33E-08	4.31E-08	5.60E-07
0.576996	PCB 66 (2 3'4 4')	2.51E-09	8.13E-09	1.06E-07
1.049426	PCB 8 (2 4)	4.55E-09	1.48E-08	1.92E-07
80.40018	**PCB Sum of the Congeners**	3.67E-07	**1.19E-06**	**1.55E-05**
0.516796	mirex	2.02E-09	6.55E-09	8.53E-08
1.252986	o,p'-DDE	9.24E-10	3.00E-09	3.91E-08
1.700958	p,p'-DDE	1.25E-09	4.07E-09	5.29E-08
25.638774	naphthalene	NT	NT	NT
136.7814	tributyltin	NT	NT	NT
	TOTAL RISK:	**1.03E-05**	**2.75E-05**	**3.27E-04**

Bold Text indicates those chemicals which are significant contributors (i.e. cancer risk > 1.00E-06) to the cancer risk
The cancer risks for PCBs (total) are as follows: Child (7.34E-07), Adult (2.38E-06), and Fisherman (3.10E-05)
EPC = Exposure Point Concentration
NT - Risk not calculated: No toxicity factor available for this compound
*** wet weight**

TABLE 6-5
ESTIMATED CTE CANCER RISKS - INDIGENOUS BLUE MUSSELS USING EPC = Average
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration*	Substance	Estimated Incremental Cancer Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
20.16	aluminum	NT	NT	NT
1.015	**arsenic**	**3.30E-06**	**1.07E-05**	**1.39E-04**
0.12152	cadmium	NT	NT	NT
0.3724	chromium	NT	NT	NT
1.0738	copper	NT	NT	NT
37.1	iron	NT	NT	NT
2.338	manganese	NT	NT	NT
0.02422	mercury	NT	NT	NT
0.3136	nickel	NT	NT	NT
15.12	zinc	NT	NT	NT
0.6776	1-methylnaphthalene	NT	NT	NT
1.204	2-methylnaphthalene	NT	NT	NT
0.4368	acenaphthene	NT	NT	NT
13.342	anthracene	NT	NT	NT
31.22	**benz(a)anthracene**	4.94E-08	1.61E-07	**2.09E-06**
14	**benzo(a)pyrene**	2.21E-07	7.20E-07	**9.37E-06**
63.28	**benzo(b,j,k)fluoranthene**	1.00E-07	3.26E-07	**4.23E-06**
0.728	1,1-biphenyl	NT	NT	NT
25.2	chrysene	3.99E-10	1.30E-09	1.68E-08
1.2656	dibenz(a,h)anthracene	2.00E-08	6.51E-08	8.46E-07
67.06	fluoranthene	NT	NT	NT
2.898	fluorene	NT	NT	NT
3.724	indeno(1,2,3-cd)pyrene	5.89E-09	1.92E-08	2.49E-07
49.56	pyrene	NT	NT	NT
5.432	PCB 101 (2 2'3 5 5')	2.35E-08	7.66E-08	9.95E-07
0.9156	PCB 105 (2 3 3'4 4')	3.98E-09	1.29E-08	1.68E-07
4.046	PCB 118 (2 3'4 4'5)	1.75E-08	5.70E-08	7.41E-07
2.324	PCB 128 (2 2'3 3'4 4')	1.01E-08	3.28E-08	4.26E-07
11.844	**PCB 138 (2 2'3 4 4'5)**	5.14E-08	1.67E-07	**2.17E-06**
16.8	**PCB 153 (2 2'4 4'5 5')**	7.29E-08	2.37E-07	**3.08E-06**
0.4564	PCB 170 (2 2'3 3'4 4'5)	1.97E-09	6.43E-09	8.36E-08
0.3486	PCB 18 (2 2'5)	1.51E-09	4.91E-09	6.38E-08
2.184	PCB 180 (2 2'3 4 4'5 5')	9.48E-09	3.08E-08	4.00E-07
5.544	**PCB 187 (2 2'3 4'5 5'6)**	2.41E-08	7.81E-08	**1.02E-06**
0.1526	PCB 195 (2 2'3 3'4 4'5 6)	6.62E-10	2.16E-09	2.80E-08
0.4466	PCB 206 (2 2'3 3'4 4'5 5'6)	1.93E-09	6.29E-09	8.18E-08
0.5152	PCB 209 (2 2'3 3'4 4'5 5'6 6')	2.24E-09	7.27E-09	9.44E-08
1.456	PCB 28 (2 4 4')	6.31E-09	2.06E-08	2.66E-07
1.022	PCB 44 (2 2'3 5')	4.44E-09	1.44E-08	1.88E-07
2.198	PCB 52 (2 2'5 5)	9.53E-09	3.09E-08	4.03E-07
0.308	PCB 66 (2 3'4 4')	1.34E-09	4.34E-09	5.64E-08
0.5866	PCB 8 (2 4)	2.55E-09	8.26E-09	1.07E-07
56.28	**PCB Sum of the Congeners**	2.45E-07	7.97E-07	**1.04E-05**
0.3304	mirex	1.29E-09	4.19E-09	5.45E-08
0.7644	o,p'-DDE	5.64E-10	1.83E-09	2.38E-08
1.2278	p,p'-DDE	9.06E-10	2.94E-09	3.82E-08
7.854	naphthalene	NT	NT	NT
20.3	tributyltin	NT	NT	NT
	TOTAL RISK:	**4.20E-06**	**1.28E-05**	**1.63E-04**

Bold Text indicates those chemicals which are significant contributors (i.e. cancer risk > 1.00E-06) to the cancer risk

The cancer risks for PCBs (total) are as follows: Child (4.90E-07), Adult (1.59E-06), and Fisherman (2.08E-05)

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

***wet weight**

TABLE 6-6
ESTIMATED RME CANCER RISKS - LOBSTER INGESTION USING EPC = MAXIMUM
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration*	Substance	Estimated Incremental Cancer Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
4.35456	aluminum	NT	NT	NT
4.0096	**arsenic**	**1.30E-05**	**4.24E-05**	**5.50E-04**
0.0784	cadmium	NT	NT	NT
0.3024	chromium	NT	NT	NT
27.5646	copper	NT	NT	NT
11.4296	iron	NT	NT	NT
0.6356	manganese	NT	NT	NT
0.06356	mercury	NT	NT	NT
0.2632	nickel	NT	NT	NT
0.9618	silver	NT	NT	NT
23.996	zinc	NT	NT	NT
1.856442	1-methylnaphthalene	NT	NT	NT
2.083774	2-methylnaphthalene	NT	NT	NT
4.555992	acenaphthene	NT	NT	NT
1.148714	anthracene	NT	NT	NT
4.060714	benz(a)anthracene	6.43E-09	2.09E-08	2.72E-07
4.021598	**benzo(a)pyrene**	6.37E-08	2.07E-07	**2.69E-06**
8.5345	benzo(b,j,k)fluoranthene	1.35E-08	4.38E-08	5.71E-07
1.9929	1,1-biphenyl	NT	NT	NT
5.402124	chrysene	8.55E-11	2.77E-10	3.61E-09
14.06818	fluoranthene	NT	NT	NT
2.088296	fluorene	NT	NT	NT
1.47945	indeno(1,2,3-cd)pyrene	2.34E-09	7.60E-09	9.90E-08
17.302404	pyrene	NT	NT	NT
5.23306	PCB 101 (2 2'3 5 5')	2.27E-08	7.38E-08	9.59E-07
29.20855	**PCB 105 (2 3 3'4 4')**	1.27E-07	4.12E-07	**5.35E-06**
9.650522	**PCB 118 (2 3'4 4'5)**	4.19E-08	1.36E-07	**1.76E-06**
1.734278	PCB 128 (2 2'3 3'4 4')	7.53E-09	2.45E-08	3.18E-07
9.965172	**PCB 138 (2 2'3 4 4'5)**	4.33E-08	1.40E-07	**1.82E-06**
13.87477	**PCB 153 (2 2'4 4'5 5')**	6.02E-08	1.96E-07	**2.55E-06**
1.71143	PCB 170 (2 2'3 3'4 4'5)	7.43E-09	2.41E-08	3.14E-07
1.501584	PCB 18 (2 2'5)	6.51E-09	2.11E-08	2.74E-07
4.793432	PCB 180 (2 2'3 4 4'5 5')	2.09E-08	6.75E-08	8.78E-07
4.409538	PCB 187 (2 2'3 4'5 5'6)	1.92E-08	6.22E-08	8.08E-07
0.656516	PCB 195 (2 2'3 3'4 4'5 6)	2.86E-09	9.25E-09	1.20E-07
1.00989	PCB 206 (2 2'3 3'4 4'5 5'6)	4.38E-09	1.43E-08	1.85E-07
0.809424	PCB 209 (2 2'3 3'4 4'5 5'6 6'	3.51E-09	1.14E-08	1.48E-07
5.711846	**PCB 28 (2 4 4')**	2.48E-08	8.05E-08	**1.05E-06**
1.21184	PCB 44 (2 2'3 5')	5.26E-09	1.71E-08	2.23E-07
1.83351	PCB 52 (2 2'5 5)	7.95E-09	2.59E-08	3.36E-07
2.715174	PCB 66 (2 3'4 4')	1.18E-08	3.82E-08	4.97E-07
1.019844	PCB 8 (2 4)	4.42E-09	1.44E-08	1.86E-07
60.238	**PCB Sum of the Congeners**	4.21E-07	**1.37E-06**	**1.78E-05**
0.175952	hexachlorobenzene	6.10E-10	1.99E-09	2.58E-08
0.21665	mirex	8.46E-10	2.74E-09	3.57E-08
0.99239	o,p'-DDE	7.32E-10	2.38E-09	3.09E-08
1.37137	p,p'-DDE	1.01E-09	3.29E-09	4.27E-08
4.928602	naphthalene	NT	NT	NT
	TOTAL RISK:	**1.40E-05**	**4.44E-05**	**5.72E-04**

Bold Text indicates those chemicals which are significant contributors (i.e. cancer risk > 1.00E-06) to the cancer risk

The cancer risks for PCBs (total) are as follows: Child (8.42E-07), Adult (2.74E-06), and Fisherman (3.56E-05)

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

*wet weight

TABLE 6-7
ESTIMATED CTE CANCER RISKS - LOBSTER INGESTION USING EPC = Average
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration*	Substance	Estimated Incremental Cancer Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
0.7098	aluminum	NT	NT	NT
3.108	**arsenic**	**1.01E-05**	**3.29E-05**	**4.27E-04**
0.0455	cadmium	NT	NT	NT
0.266	chromium	NT	NT	NT
17.78	copper	NT	NT	NT
5.558	iron	NT	NT	NT
0.406	manganese	NT	NT	NT
0.04494	mercury	NT	NT	NT
0.2086	nickel	NT	NT	NT
0.6636	silver	NT	NT	NT
16.8	zinc	NT	NT	NT
0.9688	1-methylnaphthalene	NT	NT	NT
1.253	2-methylnaphthalene	NT	NT	NT
0.6706	acenaphthene	NT	NT	NT
0.5824	anthracene	NT	NT	NT
1.0122	benz(a)anthracene	1.61E-09	5.21E-09	6.76E-08
1.2068	benzo(a)pyrene	1.92E-08	6.20E-08	8.06E-07
3.248	benzo(b,j,k)fluoranthene	5.17E-09	1.67E-08	2.17E-07
0.658	1,1-biphenyl	NT	NT	NT
1.365	chrysene	2.16E-11	7.01E-11	9.13E-10
6.664	fluoranthene	NT	NT	NT
0.3528	fluorene	NT	NT	NT
0.3822	indeno(1,2,3-cd)pyrene	6.05E-10	1.96E-09	2.56E-08
7.98	pyrene	NT	NT	NT
1.764	PCB 101 (2 2'3 5 5')	7.66E-09	2.49E-08	3.23E-07
6.342	**PCB 105 (2 3 3'4 4')**	2.76E-08	8.93E-08	**1.16E-06**
4.41	PCB 118 (2 3'4 4'5)	1.92E-08	6.22E-08	8.08E-07
0.7546	PCB 128 (2 2'3 3'4 4')	3.28E-09	1.06E-08	1.38E-07
5.222	PCB 138 (2 2'3 4 4'5)	2.27E-08	7.36E-08	9.56E-07
7.392	**PCB 153 (2 2'4 4'5 5')**	3.21E-08	1.04E-07	**1.35E-06**
1.001	PCB 170 (2 2'3 3'4 4'5)	4.34E-09	1.41E-08	1.83E-07
0.441	PCB 18 (2 2'5)	1.92E-09	6.22E-09	8.08E-08
2.394	PCB 180 (2 2'3 4 4'5 5')	1.04E-08	3.37E-08	4.38E-07
2.212	PCB 187 (2 2'3 4'5 5'6)	9.60E-09	3.12E-08	4.05E-07
0.413	PCB 195 (2 2'3 3'4 4'5 6)	1.79E-09	5.82E-09	7.56E-08
0.7714	PCB 206 (2 2'3 3'4 4'5 5'6)	3.35E-09	1.09E-08	1.41E-07
0.5908	PCB 209 (2 2'3 3'4 4'5 5'6 6')	2.56E-09	8.33E-09	1.08E-07
1.3314	PCB 28 (2 4 4')	5.78E-09	1.88E-08	2.44E-07
0.658	PCB 44 (2 2'3 5')	2.86E-09	9.27E-09	1.21E-07
1.1914	PCB 52 (2 2'5 5)	5.17E-09	1.68E-08	2.18E-07
1.736	PCB 66 (2 3'4 4')	7.53E-09	2.45E-08	3.18E-07
0.3654	PCB 8 (2 4)	1.58E-09	5.15E-09	6.69E-08
38.78	**PCB Sum of the Congeners**	1.69E-07	5.50E-07	**7.14E-06**
0.10948	hexachlorobenzene	3.79E-10	1.23E-09	1.61E-08
0.11396	mirex	4.45E-10	1.44E-09	1.88E-08
0.1736	o,p'-DDE	1.28E-10	4.16E-10	5.40E-09
0.8624	p,p'-DDE	6.36E-10	2.07E-09	2.69E-08
1.624	naphthalene	NT	NT	NT
	TOTAL RISK:	**1.05E-05**	**3.36E-05**	**4.36E-04**

Bold Text indicates those chemicals which are significant contributors (i.e. cancer risk > 1.00E-06) to the cancer risk
The cancer risks for PCBs (total) are as follows: Child (3.38E-07), Adult (1.10E-06), and Fisherman (1.43E-05)
EPC = Exposure Point Concentration
NT - Risk not calculated: No toxicity factor available for this compound
***wet weight**

TABLE 6-8
ESTIMATED RME NONCARCINOGENIC RISKS -
HARD CLAM INGESTION USING EPC = MAXIMUM
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration*	Substance	Estimated Incremental Noncarcinogenic Risk		
		Child Resident	Adult Resident	Subsistence Fisherman
		Ingestion	Ingestion	Ingestion
14.1624	aluminum	3.58E-04	2.32E-04	3.02E-03
1.3104	arsenic	1.11E-01	7.18E-02	9.34E-01
0.126	cadmium	3.19E-03	2.07E-03	2.69E-02
0.3444	chromium	1.75E-03	1.13E-03	1.47E-02
2.0132	copper	1.27E-03	8.27E-04	1.08E-02
35.9408	iron	3.04E-03	1.97E-03	2.56E-02
2.7902	manganese	5.04E-04	3.28E-04	4.26E-03
0.023464	mercury	5.94E-03	3.86E-03	5.01E-02
0.5586	nickel	7.07E-04	4.59E-04	5.96E-03
0.1932	silver	9.79E-04	6.36E-04	8.26E-03
18.3876	zinc	1.55E-03	1.01E-03	1.31E-02
0.914564	acenaphthene	3.86E-07	2.51E-07	3.26E-06
4.250022	anthracene	3.58E-07	2.32E-07	3.02E-06
18.6032	benz(a)anthracene	NT	NT	NT
6.298936	benzo(a)pyrene	NT	NT	NT
18.035	benzo(b,j,k)fluoranthene	NT	NT	NT
9.4318	chrysene	NT	NT	NT
25.004756	fluoranthene	1.58E-05	1.03E-05	1.34E-04
1.11321	fluorene	7.04E-07	4.58E-07	5.95E-06
3.761744	indeno(1,2,3-cd)pyrene	NT	NT	NT
27.601056	pyrene	2.32E-05	1.51E-05	1.96E-04
3.0289	PCB 101 (2 2'3 5 5')	NT	NT	NT
34.219528	PCB 105 (2 3 3'4 4')	NT	NT	NT
2.581096	PCB 118 (2 3'4 4'5)	NT	NT	NT
0.915642	PCB 128 (2 2'3 3'4 4')	NT	NT	NT
6.621356	PCB 138 (2 2'3 4 4'5)	NT	NT	NT
7.864682	PCB 153 (2 2'4 4'5 5')	NT	NT	NT
1.568882	PCB 170 (2 2'3 3'4 4'5)	NT	NT	NT
0.42161	PCB 18 (2 2'5)	NT	NT	NT
3.66338	PCB 180 (2 2'3 4 4'5 5')	NT	NT	NT
2.872072	PCB 187 (2 2'3 4'5 5'6)	NT	NT	NT
0.567336	PCB 195 (2 2'3 3'4 4'5 6)	NT	NT	NT
1.131102	PCB 206 (2 2'3 3'4 4'5 5'6)	NT	NT	NT
1.380484	PCB 209 (2 2'3 3'4 4'5 5'6 6')	NT	NT	NT
3.372292	PCB 28 (2 4 4')	NT	NT	NT
1.65011	PCB 44 (2 2'3 5')	NT	NT	NT
1.626184	PCB 52 (2 2'5 5)	NT	NT	NT
3.124912	PCB 66 (2 3'4 4')	NT	NT	NT
66.536*	PCBs as Aroclor-1254	8.45E-02	5.47E-02	7.14E-01
0.39522	hexachlorobenzene	1.25E-05	8.12E-06	1.06E-04
0.148778	mirex	1.89E-05	1.22E-05	1.60E-04
0.536256	o,p'-DDE	NT	NT	NT
0.664902	p,p'-DDE	NT	NT	NT
9.3996	tributyltin	7.94E-03	5.15E-03	6.69E-02
	TOTAL RISK:	2.22E-01	1.44E-01	**1.88E+00**

Bold Text indicates those chemicals which are significant contributors (i.e. HI > 1.0) to the noncancer risk

* = Sum of the maximum concentrations of the PCB Congeners

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

*wet weight

TABLE 6-9
ESTIMATED CTE NONCARCINOGENIC RISKS - HARD CLAM INGESTION USING EPC = Average
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration[1]	Substance	Estimated Noncarcinogenic Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
9.772	aluminum	2.48E-04	1.61E-04	2.09E-03
0.945	arsenic	7.98E-02	5.18E-02	6.73E-01
0.09828	cadmium	2.49E-03	1.61E-03	2.10E-02
0.2772	chromium	1.40E-03	9.11E-04	1.18E-02
1.47	copper	9.31E-04	6.05E-04	7.85E-03
23.1	iron	1.95E-03	1.27E-03	1.65E-02
1.918	manganese	3.47E-04	2.25E-04	2.93E-03
0.01904	mercury	4.82E-03	3.14E-03	4.07E-02
0.2296	nickel	2.91E-04	1.89E-04	2.45E-03
0.04186	silver	2.11E-04	1.38E-04	1.79E-03
14.42	zinc	1.22E-03	7.90E-04	1.03E-02
0.3906	acenaphthene	1.65E-07	1.07E-07	1.39E-06
2.324	anthracene	1.96E-07	1.27E-07	1.65E-06
7.56	benz(a)anthracene	NT	NT	NT
3.304	benzo(a)pyrene	NT	NT	NT
7.112	benzo(b,j,k)fluoranthene	NT	NT	NT
5.04	chrysene	NT	NT	NT
12.334	fluoranthene	7.81E-06	5.07E-06	6.59E-05
0.4984	fluorene	3.15E-07	2.04E-07	2.66E-06
1.1186	indeno(1,2,3-cd)pyrene	NT	NT	NT
12.642	pyrene	1.07E-05	6.93E-06	9.00E-05
1.834	PCB 101 (2 2'3 5 5')	NT	NT	NT
4.564	PCB 105 (2 3 3'4 4')	NT	NT	NT
1.582	PCB 118 (2 3'4 4'5)	NT	NT	NT
0.518	PCB 128 (2 2'3 3'4 4')	NT	NT	NT
4.004	PCB 138 (2 2'3 4 4'5)	NT	NT	NT
5.572	PCB 153 (2 2'4 4'5 5')	NT	NT	NT
0.9282	PCB 170 (2 2'3 3'4 4'5)	NT	NT	NT
0.2548	PCB 18 (2 2'5)	NT	NT	NT
2.492	PCB 180 (2 2'3 4 4'5 5')	NT	NT	NT
2.03	PCB 187 (2 2'3 4'5 5'6)	NT	NT	NT
0.3052	PCB 195 (2 2'3 3'4 4'5 6)	NT	NT	NT
0.8316	PCB 206 (2 2'3 3'4 4'5 5'6)	NT	NT	NT
0.7266	PCB 209 (2 2'3 3'4 4'5 5'6 6'	NT	NT	NT
1.2684	PCB 28 (2 4 4')	NT	NT	NT
0.4774	PCB 44 (2 2'3 5')	NT	NT	NT
0.8638	PCB 52 (2 2'5 5)	NT	NT	NT
1.652	PCB 66 (2 3'4 4')	NT	NT	NT
29.68*	PCBs as Aroclor-1254	3.76E-02	2.44E-02	3.17E-01
0.11466	hexachlorobenzene	3.63E-06	2.35E-06	3.07E-05
0.08092	mirex	1.02E-05	6.65E-06	8.65E-05
0.168	o,p'-DDE	NT	NT	NT
0.413	p,p'-DDE	NT	NT	NT
6.482	tributyltin	5.47E-03	3.56E-03	4.62E-02
	TOTAL RISK:	1.37E-01	8.88E-02	1.15E+00

Bold Text indicates those chemicals which are significant contributors (i.e. HI > 1.0) to the noncancer risk

* = Sum of the average concentrations of the PCB Congeners

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

[1]**wet weight**

TABLE 6-10
ESTIMATED RME NONCARCINOGENIC RISKS -
INDIGENOUS BLUE MUSSELS USING EPC = Maximum
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration[1]	Substance	Estimated Noncarcinogenic Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
52.1668	aluminum	1.32E-03	8.58E-04	1.11E-02
1.7584	**arsenic**	1.48E-01	9.63E-02	**1.25E+00**
0.2604	cadmium	6.59E-03	4.28E-03	5.56E-02
0.441	chromium	2.23E-03	1.46E-03	1.89E-02
2.086	copper	1.32E-03	8.57E-04	1.11E-02
61.2066	iron	5.17E-03	3.36E-03	4.35E-02
5.3648	manganese	9.70E-04	6.30E-04	8.19E-03
0.039088	mercury	9.90E-03	6.43E-03	8.36E-02
0.7616	nickel	9.65E-04	6.26E-04	8.13E-03
19.9178	zinc	1.68E-03	1.09E-03	1.41E-02
2.081548	1-methylnaphthalene	1.32E-06	8.55E-07	1.11E-05
3.930346	2-methylnaphthalene	2.49E-06	1.61E-06	2.10E-05
2.19268	acenaphthene	9.25E-07	6.01E-07	7.81E-06
33.190906	anthracene	2.80E-06	1.82E-06	2.37E-05
145.61148	benz(a)anthracene	NT	NT	NT
76.726482	benzo(a)pyrene	NT	NT	NT
323.4	benzo(b,j,k)fluoranthene	NT	NT	NT
1.805272	1,1-biphenyl	9.14E-07	5.94E-07	7.71E-06
87.612014	chrysene	NT	NT	NT
6.954248	dibenz(a,h)anthracene	NT	NT	NT
183.4	fluoranthene	1.16E-04	7.53E-05	9.80E-04
5.480636	fluorene	3.47E-06	2.25E-06	2.93E-05
16.929542	indeno(1,2,3-cd)pyrene	NT	NT	NT
145.6	pyrene	1.23E-04	7.98E-05	1.04E-03
7.94962	PCB 101 (2 2'3 5 5')	NT	NT	NT
1.3489	PCB 105 (2 3 3'4 4')	NT	NT	NT
6.236454	PCB 118 (2 3'4 4'5)	NT	NT	NT
3.220644	PCB 128 (2 2'3 3'4 4')	NT	NT	NT
17.610152	PCB 138 (2 2'3 4 4'5)	NT	NT	NT
24.198342	PCB 153 (2 2'4 4'5 5')	NT	NT	NT
0.66073	PCB 170 (2 2'3 3'4 4'5)	NT	NT	NT
0.874412	PCB 18 (2 2'5)	NT	NT	NT
3.865484	PCB 180 (2 2'3 4 4'5 5')	NT	NT	NT
7.802774	PCB 187 (2 2'3 4'5 5'6)	NT	NT	NT
0.41608	PCB 195 (2 2'3 3'4 4'5 6)	NT	NT	NT
0.767886	PCB 206 (2 2'3 3'4 4'5 5'6)	NT	NT	NT
1.162056	PCB 209 (2 2'3 3'4 4'5 5'6 6')	NT	NT	NT
2.293914	PCB 28 (2 4 4')	NT	NT	NT
1.547308	PCB 44 (2 2'3 5')	NT	NT	NT
3.059574	PCB 52 (2 2'5 5)	NT	NT	NT
0.576996	PCB 66 (2 3'4 4')	NT	NT	NT
1.049426	PCB 8 (2 4)	NT	NT	NT
80.4002*	PCBs as Aroclor-1254	1.02E-01	6.60E-02	8.58E-01
0.516796	mirex	6.54E-05	4.24E-05	5.52E-04
1.252986	o,p'-DDE	NT	NT	NT
1.700958	p,p'-DDE	NT	NT	NT
25.638774	naphthalene	1.62E-05	1.05E-05	1.37E-04
136.7814	tributyltin	1.15E-01	7.49E-02	9.74E-01
	TOTAL RISK:	3.96E-01	2.56E-01	**3.34E+00**

Bold Text indicates those chemicals which are significant contributors (i.e. HI > 1.0) to the noncancer risk

* = Sum of the maximum concentrations of the PCB Congeners

NT - Risk not calculated: No toxicity factor available for this compound

[1]**wet weight**

TABLE 6-11
ESTIMATED CTE NONCARCINOGENIC RISKS - INDIGENOUS BLUE MUSSELS USING EPC = Average
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration[1]	Substance	Estimated Noncarcinogenic Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
20.16	aluminum	5.11E-04	3.32E-04	4.31E-03
1.015	arsenic	8.57E-02	5.56E-02	7.22E-01
0.12152	cadmium	3.08E-03	2.00E-03	2.59E-02
0.3724	chromium	1.89E-03	1.23E-03	1.60E-02
1.0738	copper	6.79E-04	4.41E-04	5.74E-03
37.1	iron	3.14E-03	2.03E-03	2.65E-02
2.338	manganese	4.23E-04	2.74E-04	3.57E-03
0.02422	mercury	6.13E-03	3.98E-03	5.18E-02
0.3136	nickel	3.98E-04	2.58E-04	3.35E-03
15.12	zinc	1.28E-03	8.29E-04	1.08E-02
0.6776	1-methylnaphthalene	4.28E-07	2.79E-07	3.63E-06
1.204	2-methylnaphthalene	7.62E-07	4.94E-07	6.43E-06
0.4368	acenaphthene	1.85E-07	1.20E-07	1.55E-06
13.342	anthracene	1.13E-06	7.31E-07	9.51E-06
31.22	benz(a)anthracene	NT	NT	NT
14	benzo(a)pyrene	NT	NT	NT
63.28	benzo(b,j,k)fluoranthene	NT	NT	NT
0.728	1,1-biphenyl	3.68E-07	2.39E-07	3.11E-06
25.2	chrysene	NT	NT	NT
1.2656	dibenz(a,h)anthracene	NT	NT	NT
67.06	fluoranthene	4.24E-05	2.76E-05	3.58E-04
2.898	fluorene	1.83E-06	1.19E-06	1.55E-05
3.724	indeno(1,2,3-cd)pyrene	NT	NT	NT
49.56	pyrene	4.19E-05	2.72E-05	3.53E-04
5.432	PCB 101 (2 2'3 5 5')	NT	NT	NT
0.9156	PCB 105 (2 3 3'4 4')	NT	NT	NT
4.046	PCB 118 (2 3'4 4'5)	NT	NT	NT
2.324	PCB 128 (2 2'3 3'4 4')	NT	NT	NT
11.844	PCB 138 (2 2'3 4 4'5)	NT	NT	NT
16.8	PCB 153 (2 2'4 4'5 5')	NT	NT	NT
0.4564	PCB 170 (2 2'3 3'4 4'5)	NT	NT	NT
0.3486	PCB 18 (2 2'5)	NT	NT	NT
2.184	PCB 180 (2 2'3 4 4'5 5')	NT	NT	NT
5.544	PCB 187 (2 2'3 4'5 5'6)	NT	NT	NT
0.1526	PCB 195 (2 2'3 3'4 4'5 6)	NT	NT	NT
0.4466	PCB 206 (2 2'3 3'4 4'5 5'6)	NT	NT	NT
0.5152	PCB 209 (2 2'3 3'4 4'5 5'6 6'	NT	NT	NT
1.456	PCB 28 (2 4 4')	NT	NT	NT
1.022	PCB 44 (2 2'3 5')	NT	NT	NT
2.198	PCB 52 (2 2'5 5)	NT	NT	NT
0.308	PCB 66 (2 3'4 4')	NT	NT	NT
0.5866	PCB 8 (2 4)	NT	NT	NT
56.28*	PCBs as Aroclor-1254	7.13E-02	4.63E-02	6.01E-01
0.3304	mirex	4.19E-05	2.72E-05	3.53E-04
0.7644	o,p'-DDE	NT	NT	NT
1.2278	p,p'-DDE	NT	NT	NT
7.854	naphthalene	4.97E-06	3.23E-06	4.20E-05
20.3	tributyltin	1.71E-02	1.11E-02	1.44E-01
	TOTAL RISK:	1.92E-01	1.25E-01	**1.62E+00**

Bold Text indicates those chemicals which are significant contributors (i.e. HI > 1.0) to the noncancer risk

* = Sum of the Average concentrations of the PCB Congeners

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

[1]**wet weight**

TABLE 6-12
ESTIMATED RME NONCARCINOGENIC RISKS - LOBSTER INGESTION USING EPC = MAXIMUM
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration[1]	Substance	Estimated NonCarcinogenic Risks		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
4.35456	aluminum	1.10E-04	7.15E-05	9.31E-04
4.0096	**arsenic**	3.39E-01	2.20E-01	**2.86E+00**
0.0784	cadmium	1.99E-03	1.29E-03	1.68E-02
0.3024	chromium	1.53E-03	9.94E-04	1.29E-02
27.5646	copper	1.75E-02	1.13E-02	1.47E-01
11.4296	iron	9.65E-04	6.26E-04	8.15E-03
0.6356	manganese	1.15E-04	7.46E-05	9.70E-04
0.06356	mercury	1.61E-02	1.04E-02	1.36E-01
0.2632	nickel	3.33E-04	2.17E-04	2.81E-03
0.9618	silver	4.87E-03	3.16E-03	4.12E-02
23.996	zinc	2.03E-03	1.31E-03	1.71E-02
1.856442	1-methylnaphthalene	1.17E-06	7.63E-07	9.91E-06
2.083774	2-methylnaphthalene	1.32E-06	8.57E-07	1.11E-05
4.555992	acenaphthene	1.92E-06	1.25E-06	1.62E-05
1.148714	anthracene	9.69E-08	6.30E-08	8.18E-07
4.060714	benz(a)anthracene	NT	NT	NT
4.021598	benzo(a)pyrene	NT	NT	NT
8.5345	benzo(b,j,k)fluoranthene	NT	NT	NT
1.9929	1,1-biphenyl	1.01E-06	6.80E-07	8.51E-06
5.402124	chrysene	NT	NT	NT
14.06818	fluoranthene	8.90E-06	5.78E-06	7.52E-05
2.088296	fluorene	1.32E-06	8.58E-07	1.12E-05
1.47945	indeno(1,2,3-cd)pyrene	NT	NT	NT
17.302404	pyrene	1.46E-05	9.48E-06	1.23E-04
5.23306	PCB 101 (2 2'3 5 5')	NT	NT	NT
29.20855	PCB 105 (2 3 3'4 4')	NT	NT	NT
9.650522	PCB 118 (2 3'4 4'5)	NT	NT	NT
1.734278	PCB 128 (2 2'3 3'4 4')	NT	NT	NT
9.965172	PCB 138 (2 2'3 4 4'5)	NT	NT	NT
13.87477	PCB 153 (2 2'4 4'5 5')	NT	NT	NT
1.71143	PCB 170 (2 2'3 3'4 4'5)	NT	NT	NT
1.501584	PCB 18 (2 2'5)	NT	NT	NT
4.793432	PCB 180 (2 2'3 4 4'5 5')	NT	NT	NT
4.409538	PCB 187 (2 2'3 4'5 5'6)	NT	NT	NT
0.656516	PCB 195 (2 2'3 3'4 4'5 6)	NT	NT	NT
1.00989	PCB 206 (2 2'3 3'4 4'5 5'6)	NT	NT	NT
0.809424	PCB 209 (2 2'3 3'4 4'5 5'6 6'	NT	NT	NT
5.711846	PCB 28 (2 4 4')	NT	NT	NT
1.21184	PCB 44 (2 2'3 5')	NT	NT	NT
1.83351	PCB 52 (2 2'5 5)	NT	NT	NT
2.715174	PCB 66 (2 3'4 4')	NT	NT	NT
1.019844	PCB 8 (2 4)	NT	NT	NT
60.238	PCBs as Aroclor-1254	7.63E-02	4.94E-02	6.42E-01
0.175952	hexachlorobenzene	5.57E-06	3.61E-06	4.70E-05
0.21665	mirex	2.74E-05	1.78E-05	2.31E-04
0.99239	o,p'-DDE	NT	NT	NT
1.37137	p,p'-DDE	NT	NT	NT
4.928602	naphthalene	3.12E-06	2.03E-06	2.63E-05
	TOTAL RISK:	4.60E-01	2.99E-01	**3.88E+00**

Bold Text indicates those chemicals which are significant contributors (i.e. HI > 1.0) to the noncancer risk

* = Sum of the maximum concentrations of the PCB Congeners

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

(1)wet weight

TABLE 6-13
ESTIMATED CTE NONCARCINOGENIC RISKS - LOBSTER INGESTION USING EPC = Average
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

Exposure Point Concentration[1]	Substance	Estimated Noncarcinogenic Risk		
		Child Resident Ingestion	Adult Resident Ingestion	Subsistence Fisherman Ingestion
0.7098	aluminum	1.79E-05	1.17E-05	1.51E-04
3.108	**arsenic**	2.62E-01	1.71E-01	**2.21E+00**
0.0455	cadmium	1.15E-03	7.48E-04	9.73E-03
0.266	chromium	1.35E-03	8.75E-04	1.14E-02
17.78	copper	1.13E-02	7.31E-03	9.49E-02
5.558	iron	4.69E-04	3.05E-04	3.96E-03
0.406	manganese	7.34E-05	4.77E-05	6.20E-04
0.04494	mercury	1.14E-02	7.39E-03	9.60E-02
0.2086	nickel	2.65E-04	1.71E-04	2.23E-03
0.6636	silver	3.36E-03	2.18E-03	2.84E-02
16.8	zinc	1.41E-03	9.21E-04	1.20E-02
0.9688	1-methylnaphthalene	6.13E-07	3.98E-07	5.18E-06
1.253	2-methylnaphthalene	7.92E-07	5.15E-07	6.69E-06
0.6706	acenaphthene	2.83E-07	1.83E-07	2.39E-06
0.5824	anthracene	4.91E-08	3.19E-08	4.14E-07
1.0122	benz(a)anthracene	NT	NT	NT
1.2068	benzo(a)pyrene	NT	NT	NT
3.248	benzo(b,j,k)fluoranthene	NT	NT	NT
0.658	1,1-biphenyl	3.33E-07	2.17E-07	2.81E-06
1.365	chrysene	NT	NT	NT
6.664	fluoranthene	4.21E-06	2.74E-06	3.56E-05
0.3528	fluorene	2.23E-07	1.46E-07	1.89E-06
0.3822	indeno(1,2,3-cd)pyrene	NT	NT	NT
7.98	pyrene	6.73E-06	4.37E-06	5.68E-05
1.764	PCB 101 (2 2'3 5 5')	NT	NT	NT
6.342	PCB 105 (2 3 3'4 4')	NT	NT	NT
4.41	PCB 118 (2 3'4 4'5)	NT	NT	NT
0.7546	PCB 128 (2 2'3 3'4 4')	NT	NT	NT
5.222	PCB 138 (2 2'3 4 4'5)	NT	NT	NT
7.392	PCB 153 (2 2'4 4'5 5')	NT	NT	NT
1.001	PCB 170 (2 2'3 3'4 4'5)	NT	NT	NT
0.441	PCB 18 (2 2'5)	NT	NT	NT
2.394	PCB 180 (2 2'3 4 4'5 5')	NT	NT	NT
2.212	PCB 187 (2 2'3 4'5 5'6)	NT	NT	NT
0.413	PCB 195 (2 2'3 3'4 4'5 6)	NT	NT	NT
0.7714	PCB 206 (2 2'3 3'4 4'5 5'6)	NT	NT	NT
0.5908	PCB 209 (2 2'3 3'4 4'5 5'6 6'	NT	NT	NT
1.3314	PCB 28 (2 4 4')	NT	NT	NT
0.658	PCB 44 (2 2'3 5')	NT	NT	NT
1.1914	PCB 52 (2 2'5 5)	NT	NT	NT
1.736	PCB 66 (2 3'4 4')	NT	NT	NT
0.3654	PCB 8 (2 4)	NT	NT	NT
38.78*	PCBs as Aroclor-1254	4.91E-02	3.19E-02	4.14E-01
0.10948	hexachlorobenzene	3.46E-06	2.25E-06	2.93E-05
0.11396	mirex	1.44E-05	9.37E-06	1.22E-04
0.1736	o,p'-DDE	NT	NT	NT
0.8624	p,p'-DDE	NT	NT	NT
1.624	naphthalene	1.03E-06	6.68E-07	8.68E-06
	TOTAL RISK:	3.42E-01	2.22E-01	**2.89E+00**

Bold Text indicates those chemicals which are significant contributors (i.e. HI > 1.0) to the noncancer risk

* = Sum of the average concentrations of the PCB Congeners

EPC = Exposure Point Concentration

NT - Risk not calculated: No toxicity factor available for this compound

(1)wet weight

TABLE 6-14
ADULT LEAD RISKS - RME EXPOSURE ASSUMPTIONS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

TYPE OF SHELLFISH	RECEPTOR ACTIVITY	MAX. SHELLFISH CONC. (MG/KG)	95 Percentile ug/dl Fetal Lead
Hard Clams	Subsistence Fishing	0.42	4.6
Blue Mussels	Subsistence Fishing	0.81	5.2
Lobster	Subsistence Fishing	0.11	4.2

Adult risks are based on EPA, 1996.

TABLE 6-15
ADULT LEAD RISKS - CTE EXPOSURE ASSUMPTIONS
MARINE HUMAN HEALTH RISK ASSESSMENT
FORMER DERECKTOR SHIPYARD
NETC - NEWPORT, RHODE ISLAND

TYPE OF SHELLFISH	RECEPTOR ACTIVITY	AVE. SHELLFISH CONC. (MG/KG)	95 Percentile ug/dl Fetal Lead
Hard Clams	Subsistence Fishing	0.19	4.3
Blue Mussels	Subsistence Fishing	0.23	4.4
Lobster	Subsistence Fishing	0.04	4.1

Adult risks are based on EPA, 1996.

TABLE 6-16
ESTIMATED RME CANCER RISKS - SEDIMENT INGESTION AND DERMAL CONTACT (SAMPLE DSY-29-S)
DERECKTOR SHIPYARD - OFFSHORE
NEWPORT, RHODE ISLAND

Substance	Exposure Point Concentration(1)	Trespasser Child Ingestion of Sediment	Trespasser Child Dermal Contact With Sediment	Trespasser Adult Ingestion of Sediment	Trespasser Adult Dermal Contact With Sediment
aluminum	37147.5	NT	NT	NT	NT
arsenic	12.46	8.19E-07	NA	2.19E-07	NA
cadmium	1.45	NT	NT	NT	NT
chromium	86.5	NT	NT	NT	NT
copper	157.75	NT	NT	NT	NT
iron	35452.5	NT	NT	NT	NT
lead	185.9	NT	NT	NT	NT
manganese	282.25	NT	NT	NT	NT
mercury	0.5	NT	NT	NT	NT
nickel	34.75	NT	NT	NT	NT
silver	0.79	NT	NT	NT	NT
zinc	392.75	NT	NT	NT	NT
1,6,7-trimethylnaphthalene	27.94	NT	NT	NT	NT
1-methylnaphthalene	50.07	NT	NT	NT	NT
1-methylphenanthrene	266.56	NT	NT	NT	NT
2,6-dimethylnaphthalene	112.32	NT	NT	NT	NT
2-methylnaphahalene	73.47	NT	NT	NT	NT
acenaphthene	188.59	NT	NT	NT	NT
acenaphthylene	300.15	NT	NT	NT	NT
anthracene	1220	NT	NT	NT	NT
benz(a)anthracene	2700	8.64E-08	NA	2.31E-08	NA
benzo(a)pyrene	2380	7.62E-07	NA	2.04E-07	NA
benzo(b,j,k)fluoranthene	5350	1.71E-07	NA	4.59E-08	NA
benzo(e)pyrene	1950	NT	NT	NT	NT
benzo(g,h,i)perylene	1110	NT	NT	NT	NT
1,1-biphenyl	29.91	NT	NT	NT	NT
chrysene	2800	8.96E-10	NA	2.40E-10	NA
dibenz(a,h)anthracene	317.43	1.02E-07	NA	2.72E-08	NA
fluoranthene	4970	NT	NT	NT	NT
fluorene	293.64	NT	NT	NT	NT
indeno(1,2,3-cd)pyrene	1020	3.26E-08	NA	8.74E-09	NA
naphthalene	76.08	NT	NT	NT	NT
perylene	610.95	NT	NT	NT	NT
phenanthrene	1609.54	NT	NT	NT	NT
pyrene	5300	NT	NT	NT	NT
PCB 101 (2 2'3 5 5')	16.7	1.46E-09	3.82E-10	3.92E-10	2.35E-10
PCB 105 (2 3 3'4 4')	6.61	5.80E-10	1.51E-10	1.55E-10	9.31E-11
PCB 118 (2 3'4 4'5)	18.38	1.61E-09	4.20E-10	4.32E-10	2.59E-10
PCB 128 (2 2'3 3'4 4')	5.14	4.51E-10	1.17E-10	1.21E-10	7.24E-11
PCB 138 (2 2'3 4 4'5)	27.04	2.37E-09	6.18E-10	6.35E-10	3.81E-10
PCB 153 (2 2'4 4'5 5')	22.8	2.00E-09	5.21E-10	5.35E-10	3.21E-10
PCB 170 (2 2'3 3'4 4'5)	7.25	6.36E-10	1.66E-10	1.70E-10	1.02E-10
PCB 18 (2 2'5)	0.68	5.96E-11	1.55E-11	1.60E-11	9.58E-12
PCB 180 (2 2'3 4 4'5 5')	13.79	1.21E-09	3.15E-10	3.24E-10	1.94E-10
PCB 187 (2 2'3 4'5 5'6)	8.54	7.49E-10	1.95E-10	2.01E-10	1.20E-10
PCB 195 (2 2'3 3'4 4'5 6)	3.83	3.36E-10	8.75E-11	8.99E-11	5.40E-11
PCB 206 (2 2'3 3'4 4'5 5'6)	17.39	1.52E-09	3.97E-10	4.08E-10	2.45E-10
PCB 209 (2 2'3 3'4 4'5 5'6 6')	105.27	9.23E-09	2.41E-09	2.47E-09	1.48E-09
PCB 28 (2 4 4')	1.66	1.46E-10	3.79E-11	3.90E-11	2.34E-11
PCB 44 (2 2'3 5')	3.94	3.45E-10	9.00E-11	9.25E-11	5.55E-11
PCB 52 (2 2'5 5)	9.69	8.50E-10	2.21E-10	2.28E-10	1.37E-10
PCB 66 (2 3'4 4')	3.87	3.39E-10	8.84E-11	9.09E-11	5.45E-11
PCB 8 (2,4)	0.6	5.26E-11	1.37E-11	1.41E-11	8.45E-12
PCB Sum of Congeners	273.19	2.40E-08	6.24E-09	6.42E-09	3.85E-09
aldrin	0.1	7.45E-11	NA	2.00E-11	NA
hexachlorobenzene	0.16	1.12E-11	NA	3.01E-12	NA
mirex	0.1	7.89E-12	NA	2.11E-12	NA
o,p'-DDE	4.96	7.39E-11	NA	1.98E-11	NA
p,p'-DDE	6.29	9.37E-11	NA	2.51E-11	NA
dibutyltin	20.58	NT	NT	NT	NT
monobutyltin	8.65	NT	NT	NT	NT
tetrabutyltin	0.5	NT	NT	NT	NT
tributyltin	60.89	NT	NT	NT	NT
	RISK	2.02E-06	1.25E-08	5.42E-07	7.70E-09
	TOTAL RISK	2.03E-06		5.49E-07	

Inorganics are in mg/kg, Organics are in ug/kg (dry weight)

* = PCB Sum of the Congeners X 2 is Approx. Equal to Amount of Aroclor in Sample and the EPC is used to estimate Noncarcinogenic Risks as Aroclor-1254

NT = No Established EPA Toxicity Factors Exist for this Compound; NA = Not Applicable for Dermal Toxicity as per EPA Region I

RME = Reasonable Maximum Exposure

(1) - dry weight

TABLE 6-17
ESTIMATED RME NONCARCINOGENIC RISKS - SEDIMENT INGESTION AND DERMAL CONTACT (SAMPLE DSY-29-S)
DERECKTOR SHIPYARD - OFFSHORE
NEWPORT, RHODE ISLAND

Substance	Exposure Point Concentration(1)	Trespasser Child Ingestion of Sediment	Trespasser Child Dermal Contact With Sediment	Trespasser Adult Ingestion of Sediment	Trespasser Adult Dermal Contact With Sediment
aluminum	37147.5	1.90E-02	NA	1.02E-03	NA
arsenic	12.46	2.12E-02	NA	1.14E-03	NA
cadmium	1.45	7.42E-04	6.44E-04	3.97E-05	7.95E-05
chromium	86.5	8.85E-03	NA	4.74E-04	NA
copper	157.75	2.02E-03	NA	1.08E-04	NA
iron	35452.5	6.04E-02	NA	3.24E-03	NA
lead	185.9	NT	NT	NT	NT
manganese	282.25	1.03E-03	NA	5.52E-05	NA
mercury	0.5	8.52E-04	NA	4.57E-05	NA
nickel	34.75	8.89E-04	NA	4.76E-05	NA
silver	0.79	8.08E-05	NA	4.33E-06	NA
zinc	392.75	6.70E-04	NA	3.59E-05	NA
1,6,7-trimethylnaphthalene	27.94	NT	NT	NT	NT
1-methylnaphthalene	50.07	6.40E-07	NA	3.43E-08	NA
1-methylphenanthrene	266.56	NT	NT	NT	NT
2,6-dimethylnaphthalene	112.32	NT	NT	NT	NT
2-methylnaphahalene	73.47	9.39E-07	NA	5.03E-08	NA
acenaphthene	188.59	1.61E-06	NA	8.61E-08	NA
acenaphthylene	300.15	NT	NT	NT	NT
anthracene	1220	2.08E-06	NA	1.11E-07	NA
benz(a)anthracene	2700	NT	NT	NT	NT
benzo(a)pyrene	2380	NT	NT	NT	NT
benzo(b,j,k)fluoranthene	5350	NT	NT	NT	NT
benzo(e)pyrene	1950	NT	NT	NT	NT
benzo(g,h,i)perylene	1110	NT	NT	NT	NT
1,1-biphenyl	29.91	3.06E-07	NA	1.64E-08	NA
chrysene	2800	NT	NT	NT	NT
dibenz(a,h)anthracene	317.43	NT	NT	NT	NT
fluoranthene	4970	6.35E-05	NA	3.40E-06	NA
fluorene	293.64	3.75E-06	NA	2.01E-07	NA
indeno(1,2,3-cd)pyrene	1020	NT	NT	NT	NT
naphthalene	76.08	9.73E-07	NA	5.21E-08	NA
perylene	610.95	NT	NT	NT	NT
phenanthrene	1609.54	NT	NT	NT	NT
pyrene	5300	9.04E-05	NA	4.84E-06	NA
PCB 101 (2 2'3 5 5')	16.7	NT	NT	NT	NT
PCB 105 (2 3 3'4 4')	6.61	NT	NT	NT	NT
PCB 118 (2 3'4 4'5)	18.38	NT	NT	NT	NT
PCB 128 (2 2'3 3'4 4')	5.14	NT	NT	NT	NT
PCB 138 (2 2'3 4 4'5)	27.04	NT	NT	NT	NT
PCB 153 (2 2'4 4'5 5')	22.8	NT	NT	NT	NT
PCB 170 (2 2'3 3'4 4'5)	7.25	NT	NT	NT	NT
PCB 18 (2 2'5)	0.68	NT	NT	NT	NT
PCB 180 (2 2'3 4 4'5 5')	13.79	NT	NT	NT	NT
PCB 187 (2 2'3 4'5 5'6)	8.54	NT	NT	NT	NT
PCB 195 (2 2'3 3'4 4'5 6)	3.83	NT	NT	NT	NT
PCB 206 (2 2'3 3'4 4'5 5'6)	17.39	NT	NT	NT	NT
PCB 209 (2 2'3 3'4 4'5 5'6 6')	105.27	NT	NT	NT	NT
PCB 28 (2 4 4')	1.66	NT	NT	NT	NT
PCB 44 (2 2'3 5')	3.94	NT	NT	NT	NT
PCB 52 (2 2'5 5)	9.69	NT	NT	NT	NT
PCB 66 (2 3'4 4')	3.87	NT	NT	NT	NT
PCB 8 (2,4)	0.6	NT	NT	NT	NT
PCB Sum of Congeners	273.19	6.99E-03	1.82E-03	3.74E-04	2.25E-04
aldrin	0.1	1.70E-06	NA	9.13E-08	NA
hexachlorobenzene	0.16	1.02E-07	NA	5.48E-09	NA
mirex	0.1	2.56E-07	NA	1.37E-08	NA
o,p'-DDE	4.96	NT	NT	NT	NT
p,p'-DDE	6.29	NT	NT	NT	NT
dibutyltin	20.58	NT	NT	NT	NT
monobutyltin	8.65	NT	NT	NT	NT
tetrabutyltin	0.5	NT	NT	NT	NT
tributyltin	60.89	1.04E-04	NA	5.56E-06	NA
	RISK	1.23E-01	2.46E-03	6.59E-03	3.04E-04
	TOTAL RISK	1.26E-01		6.90E-03	

Inorganics are in mg/kg, Organics are in ug/kg, Dry weight

* = PCB Sum of the Congeners is Approx. Equal to Amount of Aroclor in Sample and the EPC is used to estimate Noncarcinogenic Risks as Aroclor-1254

NT = No Established EPA Toxicity Factors Exist for this Compound; NA = Not Applicable for Dermal Toxicity as per EPA Region I

RME = Reasonable Maximum Exposure

(1) - dry weight

estimated as the cancer risks for the individual common congeners and again as the cancer risk for PCB Sum of the Congeners. The concentration of PCB Congeners X 2 value for PCBs (total) is accounted for in the total cancer risk shown on each table. The risk estimated for the concentration of PCB Congeners X 2 (Common congeners + PCB Sum of the congeners) is shown in a footnote on each cancer risk table. Therefore, for this risk assessment, PCB Sum of the Congeners X 2 is used to estimate cancer risk as total PCBs for the site.

The noncarcinogenic risks shown on the tables in this section is estimated based on the sum of the common congeners assumed to be approximately equal to the amount of Aroclor 1254 in each sample. Therefore, for this risk assessment, PCB Sum of the Congeners is used to estimate noncarcinogenic risk (as Aroclor-1254) for DSY Offshore samples. The rationale for using Aroclor-1254 for noncarcinogenic risks were explained in Section 4.2.

6.1.1 Scenario 1 (Future Shellfish Ingestion by Adult Residents): Cancer Risks and Non-Cancer HIs

In this scenario, cancer risks and non-cancer HIs are estimated for ingestion of hard shell clams, blue mussels, and lobsters by adult residents. The estimated pathway-specific cancer risks and non-cancer HIs for Scenario 1 are shown in Table 6-1. The estimated chemical-specific cancer risks for Scenario 1 are shown in Table 6-2 (RME, hard shell clams), Table 6-3 (CTE, hard shell clams), Table 6-4 (RME, blue mussels), Table 6-5 (CTE, blue mussels), Table 6-6 (RME, lobster), and Table 6-7 (CTE, lobster). The estimated chemical-specific non-cancer HQs and HIs for Scenario 1 are shown in Table 6-8 (RME, hard shell clams), Table 6-9 (CTE, hard shell clams), Table 6-10 (RME, blue mussels), Table 6-11 (CTE, blue mussels), Table 6-12 (RME, lobster), and Table 6-13 (CTE, lobster).

6.1.1.1 Cancer Risk - Ingestion of Hard Shell Clams

As shown in Table 6-1, Table 6-2, and Table 6-3, the estimated cancer risks for the ingestion of hard shell clams is 1.6E-05 (RME) and 1.1E-05 (CTE). The RME and CTE scenario cancer risks are within the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risks are arsenic (RME, 1.4E-05; CTE, 1.0E-05) and PCBs (Total) (RME, 2.2E-06; CTE, 8.5E-07).

6.1.1.2 Cancer Risk - Ingestion of Blue Mussels

As shown in Table 6-1, Table 6-4, and Table 6-5, the estimated cancer risks for the ingestion of blue mussels is 2.8E-05 (RME) and 1.3E-05 (CTE). The RME and CTE scenario cancer risks are within the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risk are arsenic (RME, 1.9E-05; CTE, 1.1E-05); benzo(a)pyrene (RME, 4.0E-06; CTE, 7.2E-07); benzo(b,j,k)fluoranthene (RME, 7.3E-06; CTE, 3.3E-07); and PCBs (Total) (RME, 2.4E-06; CTE, 1.6E-06).

6.1.1.3 Cancer Risk - Ingestion of Lobster

As shown in Table 6-1, Table 6-6, and Table 6-7, the estimated cancer risks for the ingestion of lobster is 4.4E-05 (RME) and 3.4E-05 (CTE). The RME and CTE scenario cancer risks are within the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risk are arsenic (RME, 4.3E-05; CTE, 3.3E-05) and PCBs (Total) (RME, 2.7E-06; CTE, 1.1E-06).

6.1.1.4 Noncancer Risk - Ingestion of Hard Shell Clams

As shown in Table 6-1, Table 6-8, and Table 6-9, the estimated HIs for the ingestion of hard shell clams is 0.1 (RME) and 0.09 (CTE). The RME and CTE scenarios are less than 1.0.

6.1.1.5 Noncancer Risk - Ingestion of Blue Mussels

As shown in Table 6-1, Table 6-10, and Table 6-11, the estimated HIs for the ingestion of blue mussels is 0.3 (RME) and 0.1 (CTE). The RME and CTE scenarios are less than 1.0.

6.1.1.6 Noncancer Risk - Ingestion of Lobster

As shown in Table 6-1, Table 6-11, and Table 6-12, the estimated HIs for the ingestion of lobster is 0.3 (RME) and 0.2 (CTE). The RME and CTE scenarios are less than 1.0.

6.1.2 Scenario 2 (Future Shellfish Ingestion by Child Residents): Cancer Risks and Non-Cancer HIs

In this scenario, cancer risks and non-cancer HIs are estimated for ingestion of hard shell clams, blue mussels, and lobsters by child residents. The estimated pathway-specific cancer risks and non-cancer HIs for Scenario 2 are shown in Table 6-1. The estimated chemical-specific cancer risks for Scenario 2 are shown in Table 6-2 (RME, hard shell clams), Table 6-3 (CTE, hard shell clams), Table 6-4 (RME, blue mussels), Table 6-5 (CTE, blue mussels), Table 6-6 (RME, lobster), and Table 6-7 (CTE, lobster). The estimated chemical-specific non-cancer HQs and HIs for Scenario 2 are shown in Table 6-8 (RME, hard shell clams), Table 6-9 (CTE, hard shell clams), Table 6-10 (RME, blue mussels), Table 6-11 (CTE, blue mussels), Table 6-12 (RME, lobster), and Table 6-13 (CTE, lobster).

6.1.2.1 Cancer Risk - Ingestion of Hard Shell Clams

As shown in Table 6-1, Table 6-2, and Table 6-3, the estimated cancer risks for the ingestion of hard shell clams is 5.1E-06 (RME) and 3.4E-06 (CTE). The RME and CTE scenario cancer risks are within the 1E-04 to 1E-06 target risk range. The principal COPC contributing to the cancer risks is arsenic (RME, 4.3E-06; CTE, 3.1E-06).

6.1.2.2 Cancer Risk - Ingestion of Blue Mussels

As shown in Table 6-1, Table 6-4, and Table 6-5, the estimated cancer risks for the ingestion of blue mussels is 1.0E-05 (RME) and 4.2E-06 (CTE). The RME and CTE scenario cancer risks are within the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risk are arsenic (RME, 5.7E-06; CTE, 3.3E-06); benzo(a)pyrene (RME, 1.2E-06; CTE, 2.2E-07), and benzo(b,j,k)fluoranthene (RME, 2.3E-06; CTE, 1.0E-07).

6.1.2.3 Cancer Risk - Ingestion of Lobster

As shown in Table 6-1, Table 6-6, and Table 6-7, the estimated cancer risks for the ingestion of lobster is 1.4E-05 (RME) and 1.1E-05 (CTE). The RME and CTE scenario cancer risks are within the 1E-04 to 1E-06 target risk range. The principal COPC contributing to the cancer risks is arsenic (RME, 1.3E-05; CTE, 1.0E-05).

6.1.2.4 Noncancer Risk - Ingestion of Hard Shell Clams

As shown in Table 6-1, Table 6-8, and Table 6-9, the estimated HIs for the ingestion of blue mussels is 0.2 (RME) and 0.1 (CTE). The RME and CTE scenarios are less than 1.0.

6.1.2.5 Noncancer Risk - Ingestion of Blue Mussels

As shown in Table 6-1, Table 6-10, and Table 6-11, the estimated HIs for the ingestion of blue mussels is 0.4 (RME) and 0.2 (CTE). The RME and CTE scenarios are less than 1.0.

6.1.2.6 Noncancer Risk - Ingestion of Lobster

As shown in Table 6-1, Table 6-12, and Table 6-13, the estimated HIs for the ingestion of lobster is 0.5 (RME) and 0.3 (CTE). The RME and CTE scenarios are less than 1.0.

6.1.3 Scenario 3 (Future Shellfishing by Subsistent Fishermen): Cancer Risks and Non-Cancer HIs

In this scenario, cancer risks and non-cancer HIs are calculated for ingestion of hard shell clams, blue mussels, and lobsters by subsistence fishermen. The estimated pathway-specific cancer risks and non-cancer HIs for Scenario 3 are shown in Table 6-1. The estimated chemical-specific cancer risks for Scenario 3 are shown in Table 6-2 (RME, hard shell clams), Table 6-3 (CTE, hard shell clams), Table 6-4 (RME, blue mussels), Table 6-5 (CTE, blue mussels), Table 6-6 (RME, lobster), and Table 6-7 (CTE, lobster). The estimated chemical-specific non-cancer HQs and HIs for Scenario 3 are shown in Table 6-8 (RME, hard shell clams), Table 6-9 (CTE, hard shell clams), Table 6-10 (RME, blue mussels), Table 6-11 (CTE, blue mussels), Table 6-12 (RME, lobster), and Table 6-13 (CTE, lobster).

6.1.3.1 Cancer Risk - Ingestion of Hard Shell Clams

As shown in Table 6-1, Table 6-2, and Table 6-3, the estimated cancer risks for the ingestion of hard shell clams is 2.0E-04 (RME) and 1.4E-04 (CTE). The RME and CTE scenario cancer risks exceed the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risk are arsenic (RME, 1.8E-04; CTE, 1.3E-04); benz(a)anthracene (RME, 1.2E-06; CTE, 5.1E-07);

benzo(a)pyrene (RME, 4.2E-06; CTE, 2.2E-06); benzo(b,j,k)fluoranthene (RME, 1.2E-06; CTE, 4.8E-07), and PCBs (total) (RME, 2.8E-05; CTE, 1.1E-05).

6.1.3.2 Cancer Risk - Ingestion of Blue Mussels

As shown in Table 6-1, Table 6-4, and Table 6-5, the estimated cancer risks for the ingestion of hard shell clams is 3.3E-04 (RME) and 1.6E-04 (CTE). The RME and CTE scenario cancer risks exceed the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risk are arsenic (RME, 2.4E-04; CTE, 1.4E-04); benz(a)anthracene (RME, 9.7E-06; CTE, 2.1E-06); benzo(a)pyrene (RME, 5.1E-05; CTE, 9.4E-06); dibenz(a,h)anthracene (RME, 4.7E-06; CTE, 8.5E-07); indeno(1,2,3-cd)pyrene (RME, 1.1E-06; CTE, 2.5E-07); benzo(b,j,k)fluoranthene (RME, 9.5E-05; CTE, 4.2E-06), and PCBs (total) (RME, 3.1E-05; CTE, 2.1E-05).

6.1.3.3 Cancer Risk - Ingestion of Lobster

As shown in Table 6-1, Table 6-6, and Table 6-7, the estimated cancer risks for the ingestion of hard shell clams is 5.7E-04 (RME) and 4.4E-04 (CTE). The RME and CTE scenario cancer risks exceed the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risk are arsenic (RME, 5.5E-04; CTE, 4.3E-04); benzo(a)pyrene (RME, 2.7E-06; CTE, 8.1E-07); and PCBs (total) (RME, 3.6E-05; CTE, 1.4E-05).

6.1.3.4 Noncancer Risk - Ingestion of Hard Shell Clams

As shown in Table 6-1, Table 6-8, and Table 6-9, the estimated HIs for the ingestion of blue mussels is 1.9 (RME) and 1.2 (CTE). The RME and CTE scenarios exceed 1.0. The principal COPCs contributing to the HI exceeding 1.0 are arsenic (RME, 0.9; CTE, 0.7) and Aroclor-1254 (RME, 0.7; CTE, 0.3). The target organ for arsenic and Aroclor-1254 is skin. No other individual HQs add up to an HI of greater than 1.0 affecting the same target organ.

6.1.3.5 Noncancer Risk - Ingestion of Blue Mussels

As shown in Table 6-1, Table 6-10, and Table 6-11, the estimated HIs for the ingestion of blue mussels is 3.3 (RME) and 1.6 (CTE). The RME and CTE scenarios exceed 1.0. The principal COPCs contributing to the HI exceeding 1.0 are arsenic (RME, 1.3; CTE, 0.7), Aroclor-1254 (RME,

0.8; CTE, 0.6), and tributyltin (RME, 0.97; CTE, 0.2). The target organ for arsenic and Aroclor-1254 is skin. No other individual HQs add up to an HI of greater than 1.0 affecting the same target organ.

6.1.3.6 Noncancer Risk - Ingestion of Lobster

As shown in Table 6-1, Table 6-12, and Table 6-13, the estimated HIs for the ingestion of lobster is 3.9 (RME) and 2.9 (CTE). The RME and CTE scenarios exceeds 1.0. The principal COPCs contributing to the HI exceeding 1.0 are arsenic (RME, 2.9; CTE, 2.2) and Aroclor-1254 (RME, 0.6, and CTE, 0.4). The target organ for arsenic and Aroclor-1254 is skin. No other individual HQs add up to an HI of greater than 1.0 affecting the same target organ.

6.1.4 Lead Results - Shellfish Ingestion

EPA's IEUBK lead model version 0.99d is used to evaluate potential exposure risks from lead in soil, dust, water, air, and shellfish for future children (ages 0 through 6 years) living nearby and consuming shellfish. Children are considered the most sensitive receptors for lead exposures. The model predicts the distribution of blood lead levels in populations in the vicinity of lead point sources. The predicted range of blood lead concentrations that may occur in a population as a result of exposures to lead is compared to a guideline concentration of 10 micrograms per deciliter (μg/dl). Effects attributed to lead exposures occur at blood lead concentrations of 10-15 μg/dl. The percentage of the population that is predicted to have blood lead concentrations greater than 10 μg/dl is compared to a protective guideline of 5 percent for the maximum percentage of individuals with blood lead levels exceeding 10 μg/dl.

As shown in Appendix C, the predicted percentage of children aged 0 to 6 years with blood lead concentrations above 10 μg/dl (based on hard shell clams concentrations and defaults for lead in air, water, and soil) are 2.25 percent (RME) and 1.99 percent (CTE). The input parameters were a lead concentration of 0.42 mg/kg (RME) and 0.19 mg/kg (CTE) and a percentage of shellfish in the diet of 4 percent. As shown in Appendix C, the predicted percentage of children aged 0 to 6 years with blood lead concentrations above 10 μg/dl (based on blue mussel concentrations and defaults for lead in air, water, and soil) are 3.05 percent (RME) and 1.99 percent (CTE). The input parameters were a lead concentration of 0.81 mg/kg (RME) and 0.23 mg/kg (CTE) and a percentage of shellfish in the diet of 4 percent. As shown in Appendix C, the predicted

percentage of children aged 0 to 6 years with blood lead concentrations above 10 μg/dl (based on lobster concentrations and defaults for lead in air, water, and soil) are 1.87 percent (RME) and 1.76 percent (CTE). The input parameters were a lead concentration of 0.11 mg/kg (RME) and 0.04 mg/kg (CTE) and a percentage of shellfish in the diet of 4 percent. The RME and CTE values for hard shell clams, blue mussels, and lobsters are all below EPA's protective level of 5 percent. Therefore, adverse effects based on lead exposure to children aged 0-6 years from ingestion of hard shell clams, blue mussels, and lobster based on exposure to maximum or average concentrations of lead are not expected to be of concern. The population histograms for lead exposure in each of the media and the model print-outs are presented in Appendix C.

The results of adult lead risks (subsistence fishermen) are shown in Table 6-14 (RME) and 6-15 (CTE). A lead concentration of 0.42 mg/kg in hard shell clams is associated with a 95 percent fetal blood lead value of 4.6 ug/dL. A lead concentration of 0.81 mg/kg in blue mussels is associated with a 95 percent fetal blood lead value of 5.2 ug/dL. A lead concentration of 0.11 mg/kg in lobster is associated with a 95 percent fetal blood lead value of 4.2 ug/dL. A lead concentration of 0.19 mg/kg in hard shell clams is associated with a 95 percent fetal blood lead value of 4.3 ug/dL. A lead concentration of 0.23 mg/kg in blue mussels is associated with a 95 percent fetal blood lead value of 4.4 ug/dL. A lead concentration of 0.04 mg/kg in lobster is associated with a 95 percent fetal blood lead value of 4.1 ug/dL. The RME and CTE value for all types of shellfish are below 10 ug/dL (EPA's protective level for children age 0-6 years).

6.1.5 Scenario 4 (Current Trespasser Child): Cancer Risks and Non-Cancer HIs

In this scenario, cancer risks and non-cancer HIs are calculated for ingestion of constituents in sediment by child trespassing visitors. The estimated pathway-specific cancer risks and non-cancer HIs for Scenario 4 are shown in Table 6-1. The estimated RME chemical-specific cancer risks for Scenario 4 are shown in Table 6-16. The estimated RME chemical-specific noncancer HQs for Scenario 4 are shown in Table 6-17.

6.1.5.1 Cancer Risk - Ingestion and Dermal Contact with Sediment

As shown in Table 6-1 and Table 6-16, the estimated cancer risks for the ingestion of and dermal contact with sediment is 2.0E-06 (RME). The RME scenario cancer risk is near the lower end of

the 1E-04 to 1E-06 target risk range. The principal COPCs contributing to the cancer risk are arsenic (RME, 8.2E-07) and benzo(a)pyrene (RME 7.6E-07).

6.1.5.2 Noncancer Risk - Ingestion and Dermal Contact with Sediment

As shown in Table 6-1 and Table 6-17, the estimated HIs for the ingestion of and dermal contact with sediment is 0.1 (RME). The RME scenario is less than 1.0.

6.1.6 Scenario 5 (Current Trespasser Adult): Cancer Risks and Non-Cancer HIs

In this scenario, cancer risks and non-cancer HIs are calculated for ingestion of constituents in sediment by adult recreational visitors. The estimated pathway-specific cancer risks and non-cancer HIs for Scenario 5 are shown in Table 6-1. The estimated RME chemical-specific cancer risks for Scenario 5 are shown in Table 6-16. The estimated RME chemical-specific noncancer HQs for Scenario 5 are shown in Table 6-17.

6.1.6.1 Cancer Risk - Ingestion and Dermal Contact with Sediment

As shown in Table 6-1 and Table 6-16, the estimated cancer risks for the ingestion of and dermal contact with sediment is 5.5E-07 (RME). The RME scenario cancer risk is below the 1E-04 to 1E-06 target risk range.

6.1.6.2 Noncancer Risk - Ingestion and Dermal Contact with Sediment

As shown in Table 6-1 and Table 6-17, the estimated HIs for the ingestion of and dermal contact with sediment is 0.007 (RME). The RME scenario is less than 1.0.

6.2 QUALITATIVE ANALYSIS OF RISKS

6.2.1 Shellfish

As indicated in Section 4.3.1, 10 COPCs are not evaluated in the quantitative shellfish ingestion risk characterization due to lack of EPA toxicity criteria (EPA, 1993a, 1994a). These COPCs

include lead (evaluated using IEUBK Lead Model in Section 6.1.4); eight PAHs (acenaphthylene, benzo(e)pyrene, benzo(g,h,i)perylene, 2,6-dimethylnaphthalene, 1-methylphenanthrene, perylene, phenanthrene, and 1,6,7-trimethylnaphthalene); and one SVOC (dibutyltin). A qualitative assessment of these COPCs is provided below.

6.2.1.1 PAHs

Of the eight PAHs, benzo(e)pyrene, benzo(g,h,i)perylene, 1-methylphenanthrene, phenanthrene, and perylene are identified in the HHRA as a COPCs in hard shell clams, blue mussels, and lobster. Acenaphthylene is identified in the HHRA as a COPC in hard shell clams and blue mussels. 2,6-Dimethylnaphthalene is identified in the HHRA as a COPC in lobster. 1,6,7-Trimethylnaphthalene is identified in the HHRA as a COPC in blue mussels.

All eight PAHs are excluded from the quantitative risk evaluation due to the lack of EPA (1997a, 1997b) toxicity values. The oral RfD for naphthalene and/or the oral SF for benzo(a)pyrene were not cross-assigned to these PAHs since EPA has not yet classified these PAHs with regard to carcinogenicity or non-carcinogenicity.

The concentrations of these eight PAHs in the media listed above are similar to those for the non-carcinogenic PAHs with EPA toxicity values (acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, and pyrene). None of these noncarcinogenic PAHs were associated with an HQ of greater than 1.0. Thus, the exclusion of these chemicals from the quantitative risk evaluation is not likely to contribute to an underestimation of potential noncarcinogenic risk.

The concentrations of these eight PAHs in the media listed above are similar to those for the carcinogenic PAHs with EPA toxicity values (benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene). These carcinogenic PAHs were associated with risks in the range of 1E-04 to 1E-06. Thus, the exclusion of these chemicals from the quantitative risk evaluation is likely to contribute to an underestimation of potential carcinogenic risk.

6.2.1.2 Butyltins

Dibutyltin is identified in the HHRA as a COPC in mussels, but is excluded from the quantitative risk evaluation due to the lack of EPA (1997) toxicity values. EPA has not classified this constituent with regard to its potential human carcinogenicity. In mussels, dibutyltin was detected in 1 of 8 samples at a concentration of 5.72 ug/kg (mean of 0.90 ug/kg). Tributyltin was detected in value mussels in 8 of 8 samples at a range of 1.29 ug/kg to 136.78 ug/kg. Both the noncancer HQs for the RME and CTE scenarios are less than 1.0 for tributyltin under all three exposure scenarios. Thus, the exclusion of dibutyltin will not contribute to a significant underestimation of the potential noncarcinogenic risk.

6.2.2 Sediment

As indicated in Section 4.3.2, 12 COPCs are not evaluated in the quantitative sediment ingestion and dermal contact risk characterization due to lack of EPA toxicity criteria (EPA, 1993a, 1994a). These COPCs include lead; eight PAHs (acenaphthylene, benzo(e)pyrene, benzo(g,h,i)perylene, 2,6-dimethylnaphthalene, 1-methylphenanthrene, perylene, phenanthrene, and 1,6,7-trimethylnaphthalene); and three SVOCs (dibutyltin, monobutyltin, and tetrabutyltin). A qualitative assessment of these COPCs is provided below.

6.2.2.1 Lead

Recreational receptors were not evaluated for lead exposure in sediment. Due to the low exposure frequency (7 days per year), it is unlikely that the lead concentration (185.9 mg/kg) in sediment sample DSY-29-S will be associated with any significant risks to recreational receptors, however, it is always preferable to minimize lead exposure, especially to young children.

6.2.2.2 PAHs

Of the eight PAHs, benzo(e)pyrene, benzo(g,h,i)perylene, 1-methylphenanthrene, phenanthrene, and perylene are identified in the HHRA as a COPCs in sediment. All eight PAHs are excluded from the quantitative risk evaluation due to the lack of EPA (1997a, 1997b) toxicity values. The oral RfD for naphthalene and/or the oral SF for benzo(a)pyrene were not cross-assigned to these

PAHs since EPA has not yet classified these PAHs with regard to carcinogenicity or non-carcinogenicity.

The concentrations of these eight PAHs in the media listed above are similar to those for the non-carcinogenic PAHs with EPA toxicity values (acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, and pyrene). None of these noncarcinogenic PAHs were associated with an HQ of greater than 1.0. Thus, the exclusion of these chemicals from the quantitative risk evaluation is not likely to contribute to an underestimation of potential noncarcinogenic risk.

The concentrations of these eight PAHs in the media listed above are similar to those for the carcinogenic PAHs with EPA toxicity values (benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene). These carcinogenic PAHs were associated with risks below 1E-06. Thus, the exclusion of these chemicals from the quantitative risk evaluation is not likely to contribute to an underestimation of potential carcinogenic risk.

6.2.2.3 Butyltins

Dibutyltin, monobutyltin, and tetrabutyltin are identified in the HHRA as COPCs in sediment, but are excluded from the quantitative risk evaluation due to the lack of EPA (1997) toxicity values. EPA has not classified these constituents with regard to potential human carcinogenicity. In sediment, dibutyltin (20.58 ug/kg), monobutyltin (8.65 ug/kg), tetrabutyltin (0.5 ug/kg) were all detected at lower concentrations than tributyltin (60.89 ug/kg). The noncancer HQs for the RME scenario are less than 1.0 for tributyltin under both the child and adult recreational exposure scenarios. Thus, the exclusion of dibutyltin, monobutyltin, and tetrabutyltin will not contribute to a significant underestimation of the potential noncarcinogenic risk.

6.3 RISK CHARACTERIZATION SUMMARY

The risk characterization section is summarized in the following sections: Carcinogenic Risks, Noncarcinogenic Risks, and Lead Modeling Results.

6.3.1 Carcinogenic Risks

For the child resident, adult resident, and subsistence fisherman, all carcinogenic risks under RME and CTE are greater than 1E-06. The exposure pathway yielding the highest risk is the ingestion of lobster scenario for the child resident (RME risk = 1.4E-05), adult resident (RME risk = 4.4E-05), and the subsistence fisherman (RME risk = 5.7E-04). Arsenic is the main contributor to all carcinogenic risks at DSY Offshore Areas for ingestion of shellfish exposure pathways. PAHs and PCBs are minor contributors to the carcinogenic risks. For the adult trespasser, all carcinogenic risks under a RME scenario is less than 1E-06. However, the carcinogenic risk to the child trespasser was 2E-06 under this RME scenario.

6.3.2 Noncarcinogenic Risks

For the subsistence fisherman, noncarcinogenic risks for ingestion of blue mussels and lobster under RME and CTE are greater than 1.0. Additionally, noncarcinogenic risks for ingestion of hard shell calms under RME are greater than 1.0. The exposure pathway yielding the highest risk is the ingestion of lobster scenario for the subsistence fisherman (RME HI = 3.9). Arsenic is the main contributor to all noncarcinogenic risks at DSY Offshore Areas for ingestion of shellfish exposure pathways. Tributyltin is a minor contributor to the noncarcinogenic risks for hard shell clams and blue mussels. For the child recreational visitor and adult recreational visitor, all noncarcinogenic risks under a RME scenario are less than 1.0.

6.3.3 Lead Modeling Results

The predicted percentage of children aged 0 to 6 years with blood lead concentrations above 10 μg/dl based on hard shell clams concentrations are 2.25 percent (RME) and 1.99 percent (CTE), based on blue mussel concentrations are 3.05 percent (RME) and 1.99 percent (CTE), and based on lobster concentrations are 1.87 percent (RME) and 1.76 percent (CTE). The RME and CTE values for hard shell clams, blue mussels, and lobsters are all below EPA's protective level of 5 percent. Therefore, adverse effects based on lead exposure to children aged 0-6 years from ingestion of hard shell clams, blue mussels, and lobster based on exposure to maximum or average concentrations of lead are not expected to be of concern.

The results of adult lead risks (subsistence fishermen) for the RME are as follows: a lead concentration of 0.42 mg/kg in hard shell clams is associated with a 95 percent fetal blood lead value of 4.6 ug/dL, a lead concentration of 0.81 mg/kg in blue mussels is associated with a 95 percent fetal blood lead value of 5.2 ug/dL, and a lead concentration of 0.11 mg/kg in lobster is associated with a 95 percent fetal blood lead value of 4.2 ug/dL. The results of adult lead risks (subsistence fishermen) for the CTE are as follows: a lead concentration of 0.19 mg/kg in hard shell clams is associated with a 95 percent fetal blood lead value of 4.3 ug/dL, a lead concentration of 0.23 mg/kg in hard shell clams is associated with a 95 percent fetal blood lead value of 4.4 ug/dL, and a lead concentration of 0.04 mg/kg in hard shell clams is associated with a 95 percent fetal blood lead value of 4.1 ug/dL. The RME and CTE value for all types of shellfish are below 10 ug/dL (EPA's protective level for children age 0-6 years).

7.0 UNCERTAINTY ASSESSMENT

Each component of the HHRA (hazard identification, dose-response assessment, exposure assessment, and risk characterization) contributes some degree of uncertainty to the quantitative estimates of potential health risk. This section discusses general and site-specific uncertainties associated with each component. Examples of site-specific uncertainties include COPC selection, lack of EPA toxicity values for identified COPCs, assumptions about the nature and frequency of exposures to site-related constituents, and uncertainties associated with the constituents contributing the most to the estimated cancer risks and non-cancer HIs.

7.1 UNCERTAINTIES RELATED TO THE HAZARD IDENTIFICATION

The primary sources of uncertainty associated with the hazard identification are the environmental sampling and analysis, and the subsequent selection of COPCs.

As described previously, shellfish and sediment samples were collected and analyzed for a variety of constituents including inorganics, VOCs, SVOCs, pesticides, and PCBs. There are several potential sources of uncertainty associated with the collection and analysis of these samples. First, the list of constituents analyzed, although fairly comprehensive, may not reflect all of the constituents present in the shellfish. Second, the number of samples analyzed may not be sufficiently large to characterize with high confidence the distribution of constituent concentrations in each medium. This could lead to an under- or over-estimation of (for example) the frequency and magnitude of concentrations. Finally, there are uncertainties associated with the analytical methods and instruments used in the analysis of samples. For example, the values reported as non-detected may actually range from non-detect (not present) up to the value of the SQL. The replacement of non-detected values with a value equal to the SQL or one-half the SQL is intended to be reasonably conservative, but could over- or underestimate the actual constituent concentrations present in the environmental media. SQLs are generally not elevated in the datasets for this project.

The selection of COPCs is intended to identify those constituents that are likely to be site related. Most of the uncertainty in this HHRA is due to the fact that all chemicals detected in shellfish were selected as COPCs because less than 20 samples were collected in each of the three

shellfish media (hard shell calms, blue mussels, and lobster). Therefore the 5 percent frequency rule sometimes used for elimination of COPCs did not apply. Additionally, the use of a sediment sample collected in Coddington Cove to represent conditions present on a rehabilitated beach area south of the site is a major source of uncertainty for the recreational exposure scenarios. Despite these uncertainties, the COPC selection process is intended to be conservative with an aim toward being inclusive, rather than limited in nature. This probably leads to an overestimation of the risks at the site.

7.2 UNCERTAINTIES RELATED TO THE DOSE-RESPONSE ASSESSMENT

There are several main sources of uncertainty related to the toxicity information. First, the availability and quality of toxicity data affect the ability of experts to derive toxicity criteria and the quality/certainty of the toxicity criteria that are derived. The exclusion of COPCs without toxicity criteria from the quantitative risk characterization also represents a potential source of uncertainty. As indicated in Section 4.3 and discussed further in Section 6.2, EPA (1997a, 1997b) toxicity values are not available for 13 COPCs. Based on the qualitative evaluation in Section 6.2, exclusion of most of these COPCs from the quantitative analysis is not likely to contribute to an underestimation of potential health risk.

The uncertainty associated with the toxicity values for each constituent contributes to the overall uncertainty in the risk characterization of the site. The possible sources of uncertainty for a given constituent include: the number of available studies, the quality of these studies, the consistency among the study results (across species, strains, sex, and exposure pathways), the plausibility of the biological mechanism, and the existence and nature of a dose-response relationship. The quality of individual studies is influenced by some of these same factors as well as the test species, the dose used, the route of exposure, the length of exposure, and other study design issues (sample size and statistical power). For example, animal to human extrapolation, high dose to low dose extrapolation, and short-term to long-term extrapolation often introduce considerable uncertainty into the derivation of toxicity values.

An additional source of uncertainty in the toxicity assessment is the use of toxicity values of one constituent for other structurally similar constituents, as in the case of PAHs. Although the assignment of the benzo(a)pyrene cancer slope factor to other carcinogenic PAH constituents follows current Region I guidance (EPA, 1989a), this approach likely creates a considerable

overestimate of risk since benzo(a)pyrene is one of the most potent PAH constituents (Rugen et al., 1989; ICF-Clement, 1987; EPA, 1985). For PCBs, there is some uncertainty associated with the estimated risks since the oral slope factor is based on Aroclor-1260 and the PCBs identified as COPCs in the data are PCB congeners that are not specified in terms of the amount of Aroclor constituents contained in them.

Additionally, regarding PAHs, the shellfish tissue and sediment samples analyzed for benzo(b)fluoranthene and benzo(k)fluoranthene were reported by the laboratory together as benzo(b,j,k)fluoranthene. Therefore, the more conservative (higher) of the relative potency factors of these two compounds [benzo(b)fluoranthene, RPF = 0.1 of benzo(a)pyrene's toxicity value] was used in this risk assessment and applied to the concentrations reported by the laboratory as benzo(b,j,k)fluoranthene.

The shellfish tissue and sediment samples analyzed for PCB congeners were reported by the laboratory specific to the PCB congener and were not reported by Aroclor. Aroclor-1254 is the most common non-carcinogenic Aroclor found at industrial sites such as DSY. Therefore, the PCB sum of the congeners will be carried through the risk assessment for non-cancer risk and assumed to all be Aroclor-1254. This represents a conservative approach for noncarcinogenic risk for PCB exposure, and likely overestimates the noncarcinogenic risk at the site.

Arsenic risks at the site were based on EPA's arsenic slope factor and RfD. These toxicity factors were based on studies performed using arsenic trioxide (As2O3). However, arsenic in seafood exists in an organic state known as arsenobetaine, or fish arsenics. Approximately 80 to 90 percent of the arsenic available in seafood is present in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January 1993). Therefore, the levels of risk estimated for arsenic in seafood in the site area are certainly overestimates because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine.

7.3 UNCERTAINTIES RELATED TO THE EXPOSURE ASSESSMENT

Assumptions are inherent in any assessment of exposure and risk. This section identifies and quantifies, to the extent possible, the uncertainties associated with the exposure assessment for the site. The potential areas of uncertainty include the selection of current and anticipated future

land uses, selection of exposure pathways, calculation and modeling of EPCs, and the selection of specific exposure parameters.

This HHRA considers potential risks associated with future shellfish ingestion and current sediment ingestion and dermal contact. As discussed in Section 5.0, the selected pathways are intended to represent the spectrum of reasonably likely exposure and do not necessarily reflect all theoretically possible exposure scenarios. The estimated risks associated with the selected scenarios are conditioned on these current or future activities occurring at the rates specified. Further, the risks estimated for shellfish ingestion and sediment ingestion and dermal contact do not necessarily reflect site-related risk. Although the site may theoretically contribute to the constituent levels in these media, other sources (background contributions, other point/non-point sources to the Narragansett Bay) are likely to exist. Of the scenarios evaluated, future shellfishing is the most uncertain given the current ban on such activities in the area of the site, the industrial nature of the site, and the water depth at most stations. In addition, a major uncertainty exists under the trespasser exposure scenario, a surrogate media (a sediment sample collected in Coddington Cove) was used to represent exposure at the beach south of the site.

The exposure pathways evaluated include ingestion of shellfish by child residents, adult residents, and subsistence fishermen and ingestion of and dermal contact with sediment by recreational children and adults. The risks associated with these exposure pathways are conditioned on the land uses and exposure routes occurring.

The hepatopancreas ("Tamale" or liver) was not included under the lobster ingestion exposure pathway. The analytical laboratory (URI GSO) cited difficulty with analytical procedures with a material that is so high in lipid content. The fact that this organ tends to accumulate toxins might underestimate the carcinogenic and noncarcinogenic risks for the lobster ingestion exposure pathway. However, the hepatopancreas is also small in size compared with the rest of the edible lobster tissue, therefore, the exposure to the chemicals in this organ is expected to be lower than the rest of the lobster tissue consumed. An additional uncertainty exists for hepatopancreas exposure regarding the number of individuals who would be expected to consume this organ (expected to be less than 100% of individuals exposed).

For all COPCs, use of the maximum detected concentration under the RME scenarios likely overestimates the potential risk.

Tables 5-5, 5-6, and 5-7 summarizes the assumptions used to estimate exposure (ingestion rate, exposure frequency, skin surface area available for contact etc.). The exposure estimates produced for each receptor in each scenario are based on numerous variables with varying degrees of uncertainty. This discussion focuses on these parameters and the associated range of uncertainty.

7.3.1 Global Variables (All Scenarios)

Tables 5-4, 5-5, and 5-6 lists the parameters and associated values that are used in each of the scenarios. The body weight range for children (age 0 to 6 years) is derived from EPA (1990a). The actual value used represents a weighted average based on the body weights for each of the intervals within the 0 to 6 year age group. Similarly, for adults (18 to 65 years), a range of body weights is presented, along with the average body weight (70 kg) for the group. While there is a range of body weights for each age group, this exposure parameter is not expected to contribute a significant degree of uncertainty to the assessment.

The exposure duration used for the adult shellfishing and sediment scenarios is 30 years. This estimate corresponds to the 90th percentile for the length of time spent at one residence by home owners, and its use likely overstates the potential risk. The exposure duration used for the child shellfish ingestion scenario is 6 years, corresponding to ages 0 to 6.

Averaging time is the time period over which exposures are averaged. Uncertainty is expected to be minimal for the averaging time used to estimate cancer risk since it equals lifetime duration times 365 days per year. The non-cancer averaging time equals the exposure duration times 365 days per year and will therefore be more uncertain given the underlying uncertainty in exposure duration.

7.3.2 Scenario 1 (Future Adult Resident)

Of the parameters presented in Tables 5-4, 5-5, 5-6 and 5-7, the ingestion rate for hard shell clams, blue mussels, and lobster is associated with the greatest degree of uncertainty. This value, 1,200 mg/d, is based on an estimate of seafood serving sizes (150,000 mg/meal) and Rhode Island survey information on the typical number of hard-shell clam (quahog) meals per year (2.9 meals/year) (both values provided by RIDEM in Narragansett Bay Project (n.d.)). The resulting

clam ingestion rate of 1,200M g/d is three times higher than the clam ingestion rate of 442 mg/d presented by EPA (1990a). The EPA (1990a) value is based on a month-long survey that requested consumer information on the type and amount of fish consumed and is believed to represent 94 percent of the general population (see EPA, 1990a). In the absence of information on mussel ingestion rates, the Narragansett Bay Project value for clams is used (1,200 mg/d). As a comparison, the rate provided for oysters in EPA (1990a) (one for mussels was not presented) is 291 mg/d. Although the values for exposure frequency and fraction from the site area (350 day per year and 1, respectively) are likely to be associated with some uncertainty, these values are upper-bound estimates and are likely to overestimate the potential risks.

It has been reported that recreational divers regularly collect lobsters from the northern portion of the site, accessed by the protective breakwater. Therefore, the ingestion of lobster by recreational fishermen might be the most realistic of the scenarios evaluated.

7.3.3 Scenario 2 (Future Child Resident)

Of the parameters presented in Section 5, the ingestion rate for hard shell clams, blue mussels, and lobster is associated with the greatest degree of uncertainty. This value, 396 mg/d, is based on an estimated seafood serving size (48,000 mg/meal, 32 percent of 150,000 mg/meal in Scenario 1) and Rhode Island survey information on the typical number of hard-shell clam (quahog) meals per year (2.9 meals/year) (both values provided by RIDEM in Narragansett Bay Project (n.d.)). The same uncertainties associated with Scenario 1 presented above apply to Scenario 2.

It has been reported that recreational divers regularly collect lobsters from the northern portion of the site, accessed by the protective breakwater. Therefore, the ingestion of lobster by recreational fishermen might be the most realistic of the scenarios evaluated.

7.3.4 Scenario 3 (Future Shellfishing by Subsistent Fishermen)

Of the parameters presented in Section 5, the ingestion rate for hard shell clams, blue mussels, and lobster is associated with the greatest degree of uncertainty. This value, 15,600 mg/d, is based on RIDEM-provided estimates of seafood serving sizes (150,000 mg/meal) and of the number of hard-shell clam (quahog) meals eaten per year (36.5 meals per year). The resulting clam ingestion rate of 15,600 mg/d is 30 times higher than the clam ingestion rate of 442 mg/d

presented by EPA (1990a). The EPA (1990a) value is based on a month-long survey that requested consumer information on the type and amount of fish consumed and is believed to represent 94 percent of the general population (see EPA, 1990a). Although the values for exposure frequency and fraction from the site area (350 days per year and 1, respectively) are likely to be associated with some uncertainty, these values are upper-bound estimates and are likely to overestimate the potential risks.

Finally, while it is admitted that such persons exist, it is deemed most unlikely that subsistence fishermen would expend their resources collecting shellfish from an industrial port while other, more productive areas are so close by.

It should be noted that there is currently a ban on shell fishing (clams and mussels) in this portion of Narragansett Bay as the result of the proximity of the shoreline to the Newport treatment plant outfall. Therefore, Scenarios 1, 2, and 3 may represent an exposure that is unlikely to occur in the near future.

7.3.5 Scenario 4 (Current Trespasser - Child)

The primary sources of uncertainty for this scenario includes the ingestion and dermal contact rates for sediment and exposure frequency. The ingestion rate assumed (200 mg/d for sediment) is considered an upper-bound value for people under 6 years old (EPA, 1993b). As discussed above, the dermal contact rate (500 mg/d) is recommended by EPA Region I (EPA, 1989a) for assessing non-contact intensive exposures. This dermal contact rate corresponds to 2,000 cm^2 total exposed skin surface area (hands, forearms, lower legs, and feet), a soil adherence factor of 0.5 mg/cm^2, and a factor of 50 percent to account for the percentage of exposed skin surface area actually covered with soil. Although uncertain, these exposure values are likely to overestimate potential risk.

The exposure frequency used (7 d/yr) may over-estimate potential risks to trespassers. This frequency is based on the national average number of days for swimming, (EPA, 1989a), and is considered conservative given the proximity of the site to residential areas, the regional climate (e.g., little or no exposures during the winter months). In addition, conservatism is accentuated, considering this is a prohibited activity, and the area is so heavily patrolled.

7.3.6 Scenario 5 (Current Trespasser - Adult)

The primary sources of uncertainty for this scenario include the ingestion and dermal contact rates for sediment and exposure frequency. The ingestion rate assumed (100 mg/d for sediment) is considered an upper-bound value for people over 6 years old (EPA, 1993b). As discussed above, the dermal contact rate (500 mg/d) is recommended by EPA Region I (EPA, 1989a) for assessing non-contact intensive exposures. This dermal contact rate corresponds to 2,000 cm^2 total exposed skin surface area (hands and feet), a soil adherence factor of 0.5 mg/cm^2, and a factor of 50 percent to account for the percentage of exposed skin surface area actually covered with soil. Although uncertain, these exposure values are likely to overestimate potential risk.

The exposure frequency used (7 d/yr) may over-estimate potential risks to trespassers. This frequency is based on the national average number of days for swimming, (EPA, 1989a), and is considered conservative given the proximity of the site to residential areas and the regional climate (e.g., little or no exposures during the winter months). In addition, conservatism is accentuated, considering this is a prohibited activity, and the area is so heavily patrolled.

7.4 UNCERTAINTIES RELATED TO THE RISK CHARACTERIZATION

The uncertainties associated with the risk characterization may be categorized into two groups: those related to the components of the risk estimates (the estimates of exposure and toxicity) and those inherent in the risk characterization methodologies.

For the estimation of cancer risks and non-cancer HIs, the values for all constituents in each pathway have been summed to yield the total cancer risk and non-cancer HI for each pathway. Summation of cancer risks and non-cancer HQs across constituents is a general source of uncertainty in the risk characterization portion of the HHRA. This is a conservative approach since, in general, different constituents do not have the same target organ or mechanism of action. Thus, their toxic effects may be, at least in some cases, independent and not additive. Further, constituents may antagonize one another through competition for enzymes and binding sites, and by inhibition of pathways needed for constituent transport (absorption, cellular uptake, etc.) or metabolic activation. However, it is also possible that certain constituents can be synergistic, as is the case when a promotor-type carcinogen greatly enhances the expression of genetic damage induced by a low dose of an initiator.

7.4.1 Uncertainties Associated with Constituents Significantly Contributing to Elevated Cancer Risks

All total cancer risks were elevated above 1E-06 for both RME and CTE scenarios for ingestion of hard shell clams, blue mussels, and lobster for all three potential receptors. Additionally, cancer risks exceeded 1E-04 for the future subsistence fisherman (ingestion of hard shell clams, blue mussels, and lobster) for both the RME and CTE scenarios. The constituents contributing the most to the estimated pathway cancer risks for all three potential receptors include arsenic, PAHs, and PCBs.

Hard Shell Clams

In hard shell clams, arsenic was detected in all 11 samples at a range of 0.30 mg/kg to 1.31 mg/kg (mean of 0.95 mg/kg). The reference clam samples (locations JPC-1 and CHC-1) are used to evaluate the levels of arsenic in site clams. The concentrations of arsenic in the reference clam samples range from 1.08 mg/kg to 1.54 mg/kg (mean of 1.32 mg/kg), and are higher than those detected at the site. For this reason, the cancer risks estimated for arsenic in hard shell clams at the site are more likely to be bay-related rather than site-related.

With regard to toxicity, there is some uncertainty associated with the oral slope factor for arsenic since it is based on long-term exposures of humans to arsenic in drinking water. Additionally, arsenic risks at the site were based on EPA's oral slope factor. This toxicity factor was based on studies performed using arsenic trioxide (As_2O_3). However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic available in seafood is in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January 1993). Therefore, the levels of risk estimated for arsenic in seafood in the site area are certainly overestimates because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine.

With regard to exposure assumptions, the estimated cancer risks for ingestion of arsenic in clams may be overstated due to the roughly 3-fold difference in the clam ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by

RIDEM in Narragansett Bay Project (n.d.)) and a clam ingestion rate based on survey data (regional area not specified) presented in EPA (1990a).

Generally, carcinogenic PAHs were detected in all 11 hard shell clam samples at concentrations of 0.95 ug/kg (chrysene) to 18.60 ug/kg (benz(a)anthracene). The reference clam samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PAHs in clams for the site. The concentrations of the carcinogenic PAHs in the reference clam samples range from 0.07 ug/kg to 3.71 ug/kg, and are generally lower than those detected at the site. Although there is little uncertainty that PAH concentrations in hard shell clams at the site are elevated relative to those in reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels. An additional uncertainty regarding the estimated cancer risks for PAHs in clams is the use of the oral slope factor for benzo(a)pyrene. Although masked by the estimated cancer risks for arsenic, use of the benzo(a)pyrene slope factor overstates the potential risks as indicated by the TEFs for these constituents. With regard to exposure assumptions, the estimated cancer risks for ingestion of carcinogenic PAHs in clams may be overstated due to the roughly 3-fold difference in the clam ingestion rate which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and a clam ingestion rate, based on survey data (regional area not specified) presented in EPA (1990a).

Generally, 17 PCB congeners were detected in all 10 hard shell clam samples at concentrations of 11.6 ug/kg to 66.54 ug/kg (mean of 29.68 ug/kg). The reference clam samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PCBs in site clams. The concentrations of the PCB congeners in the reference clam samples range from 14.31 ug/kg to 18.66 ug/kg (mean of 16.52 ug/kg), and are generally lower than those detected at the site. Although there is little uncertainty that PCB concentrations in hard shell clams at the site are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

With regard to toxicity, the potential risks may be overstated since the oral slope factor is based on Aroclor-1260. The oral slope factor for Aroclor-1260 is based on a dietary study in rats. The uncertainty associated with this slope factor is typical of animal-based toxicity values. With regard to exposure assumptions, the estimated cancer risks for ingestion of PCBs in hard shell clams may be overstated due to the roughly 3-fold difference in the clam ingestion rate, which is

based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and a clam ingestion rate based on survey data (regional area not specified) presented in EPA (1990a).

Blue Mussels

In blue mussels, arsenic was detected in all eight samples at a range of 0.38 mg/kg to 1.76 mg/kg (mean of 1.02 mg/kg). The reference blue mussel samples collected (locations JPC-1 and CHC-1) are used to evaluate the levels of arsenic in site blue mussels. The concentrations of arsenic in the reference clam samples range from 0.66 mg/kg to 0.95 mg/kg (mean of 0.80 mg/kg), and are generally lower than those detected at the site. Although there is little uncertainty that the arsenic concentrations in site mussels are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

With regard to toxicity, there is little uncertainty associated with the oral slope factor for arsenic since it is based on long-term exposures of humans to arsenic in drinking water. Additionally, arsenic risks at the site were based on EPA's oral slope factor. However, this toxicity factor was based on studies performed using arsenic trioxide (As_2O_3). However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic available in seafood is in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January 1993). Therefore, the levels of risk estimated for arsenic in seafood in the site area are certainly overestimates because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine.

With regard to exposure assumptions, the estimated cancer risks for ingestion of arsenic in mussels may be overstated given the roughly 4-fold difference in the quahog ingestion rate which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the oyster ingestion rate which is based on survey data presented in EPA (1990a). Ingestion rates for mussels are not provided by the Narragansett Bay Project (n.d.) or EPA (1990a).

Generally, carcinogenic PAHs were detected in all eight blue mussel samples at concentrations of 0.84 ug/kg (indeno(1,2,3-cd)pyrene) to 145.61 ug/kg (benz(a)anthracene). The reference blue mussel samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PAHs in site clams. The concentrations of the carcinogenic PAHs in the reference clam samples range from 0.07 ug/kg to 6.93 ug/kg, and are generally lower than those detected at the site. Although there is little uncertainty that PAH concentrations in mussels at the site are elevated relative to the reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels. An additional uncertainty regarding the estimated cancer risks for PAHs in clams is the use of the oral slope factor for benzo(a)pyrene. Although masked by the estimated cancer risks for arsenic, use of the benzo(a)pyrene slope factor overstates the potential risks as indicated by the TEFs for these constituents.

With regard to exposure assumptions, the estimated cancer risks for ingestion of carcinogenic PAHs in mussels may be overstated given the roughly 4-fold difference in the quahog ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the oyster ingestion rate which is based on survey data presented in EPA (1990a). Ingestion rates for mussels were not provided by the Narragansett Bay Project (n.d.) or EPA (1990a).

Generally, 18 PCB congeners were detected in all eight blue mussel samples at concentrations of 36.97 ug/kg to 80.40 ug/kg (mean of 56.28 ug/kg). The reference blue mussel samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PCBs in site clams. The concentrations of the PCBs in the reference clam samples range from 27.20 ug/kg to 39.53 ug/kg (mean of 33.32 ug/kg), and are generally lower than those detected at the site. Although there is little uncertainty that the PCB concentrations in mussels at the site are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

Lobster

In lobster, arsenic was detected in all eight samples at a range of 2.27 mg/kg to 4.01 mg/kg (mean of 3.11 mg/kg). The reference lobster samples (locations JPC-1 and CHC-1) are used to evaluate the levels of arsenic in site lobster. The concentrations of the arsenic in the reference lobster samples range from 2.72 mg/kg to 3.04 mg/kg (mean of 2.88 mg/kg), and are within the

range of those detected at the site. For this reason, the cancer risks estimated for arsenic in site lobster are more likely to be bay-related rather than site-related.

With regard to toxicity, there is little uncertainty associated with the oral slope factor for arsenic since it is based on long-term exposures of humans to arsenic in drinking water. Additionally, arsenic risks at the site were based on EPA's oral slope factor. However this toxicity factor was based on studies performed using arsenic trioxide (As_2O_3). However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic available in seafood is in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January 1993). Therefore, the levels of risk estimated for arsenic in seafood in the site area are certainly overestimates because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine.

With regard to exposure assumptions, the estimated cancer risks for ingestion of arsenic in lobsters may be overstated given the roughly 4-fold difference in the quahog ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the oyster ingestion rate, which is based on survey data presented in EPA (1990a). Ingestion rates for lobsters were not provided by the Narragansett Bay Project (n.d.) or EPA (1990a), however, it has been reported that lobsters are taken by recreational divers near the north breakwater.

Generally, carcinogenic PAHs were detected in less than one-half of the nine lobster samples at concentrations of 1.20 ug/kg (indeno(1,2,3-cd)pyrene) to 4.06 ug/kg (benz(a)anthracene). The reference lobster samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PAHs in site lobster. The concentrations of the carcinogenic PAHs in the reference lobster samples range from 0.07 ug/kg to 0.73 ug/kg, and are generally lower than those detected at the site. Although there is little uncertainty that PAH concentrations in mussels at the site are elevated relative to the reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels. An additional uncertainty regarding the estimated cancer risks for PAHs in lobster is the use of the oral slope factor for benzo(a)pyrene. Although masked by the estimated cancer risks for arsenic, use of the benzo(a)pyrene slope factor overstates the potential risks as indicated by the TEFs for these constituents. With regard to exposure assumptions, the estimated cancer risks for ingestion of carcinogenic PAHs in lobster

may be overstated given the roughly 4-fold difference in the quahog ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the oyster ingestion rate, which is based on survey data presented in EPA (1990a). Ingestion rates for lobster were not provided by the Narragansett Bay Project (n.d.) or EPA (1990a).

Generally, 18 PCB congeners were detected in all nine lobster samples at concentrations of 20.34 ug/kg to 60.24 ug/kg (mean of 38.78 ug/kg). The reference lobster samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PCB in site lobster. The concentrations of the PCBs in the reference lobster samples range from 27.80 ug/kg to 32.27 ug/kg (mean of 30.1 ug/kg), and are generally within or lower than those detected at the site. Although there is little uncertainty that the PCB concentrations in lobsters at the site are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

With regard to toxicity, the potential risks may be overstated since the oral slope factor is based on Aroclor-1260. The oral slope factor for Aroclor-1260 is based on a dietary study in rats. The uncertainty associated with this slope factor is typical of animal-based toxicity values.

With regard to exposure assumptions, the estimated cancer risks for ingestion of PCBs in lobster may be overstated given the roughly 4-fold difference in the quahog ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the oyster ingestion rate, which is based on survey data presented in EPA (1990a). Ingestion rates for lobster were not provided in the Narragansett Bay Project (n.d.) or EPA (1990a).

7.4.2 Uncertainties Associated with Constituents Significantly Contributing to Elevated Non-Cancer HIs

HIs were above 1.0 for ingestion of hard shell clams, blue mussels, and lobster for the RME and CTE scenarios for subsistence fishermen. The constituents contributing the most to the estimated pathway noncancer risks for the subsistence fisherman was arsenic and to a lesser extent, PCBs.

Hard Shell Clams

In hard shell clams, arsenic was detected in all 11 samples at a range of 0.30 mg/kg to 1.31 mg/kg (mean of 0.95 mg/kg). The reference clam samples (locations JPC-1 and CHC-1) are used to evaluate the levels of arsenic in site clams. The concentrations of arsenic in the reference clam samples range from 1.08 mg/kg to 1.54 mg/kg (mean of 1.32 mg/kg), and are higher than those detected at the site. For this reason, the noncancer risks estimated for arsenic in hard shell clams at the site are more likely to be bay-related rather than site-related.

With regard to toxicity, there is some uncertainty associated with the oral reference dose for arsenic since it is based on long-term exposures of humans to arsenic in drinking water. Additionally, arsenic risks at the site were based on EPA's oral reference dose. However this toxicity factor was based on studies performed using arsenic trioxide (As_2O_3). However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic available in seafood is in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January 1993). Therefore, the levels of risk estimated for arsenic in seafood in the site area are certainly overestimates because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine. With regard to exposure assumptions, the estimated cancer risks for ingestion of arsenic in clams may be overstated due to the roughly 3-fold difference in the clam ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the clam ingestion rate, which is based on survey data (regional area not specified) presented in EPA (1990a).

Generally, 17 PCB congeners were detected in all 10 hard shell clam samples at concentrations of 11.6 ug/kg to 66.54 ug/kg (mean of 29.68 ug/kg). The reference clam samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PCBs in site clams. The concentrations of the PCB congeners in the reference clam samples range from 14.31 ug/kg to 18.66 ug/kg (mean of 16.52 ug/kg), and are generally lower than those detected at the site. Although there is little uncertainty that PCB concentrations in hard shell clams at the site are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

With regard to toxicity, the potential risks may be overstated since the oral reference dose is based on Aroclor-1254 and is applied to all PCB congeners. With regard to exposure assumptions, the estimated noncancer risks for ingestion of PCBs in hard shell clams may be overstated due to the roughly 3-fold difference in the clam ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and a clam ingestion rate based on survey data (regional area not specified) presented in EPA (1990a).

Blue Mussels

In blue mussels, arsenic was detected in all eight samples at a range of 0.38 mg/kg to 1.76 mg/kg (mean of 1.02 mg/kg). The reference blue mussel samples (locations JPC-1 and CHC-1) are used to evaluate the levels of arsenic in site blue mussels. The concentrations of arsenic in the reference clam samples range from 0.66 mg/kg to 0.95 mg/kg (mean of 0.80 mg/kg), and are generally lower than those detected at the site. Although there is little uncertainty that the arsenic concentrations in mussels at the site are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

With regard to toxicity, there is little uncertainty associated with the oral reference dose for arsenic since it is based on long-term exposures of humans to arsenic in drinking water. Additionally, arsenic risks at the site were based on EPA's oral reference dose. However, this toxicity factor was based on studies performed using arsenic trioxide (As_2O_3). However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic available in seafood is in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January 1993). Therefore, the levels of risk estimated for arsenic in seafood in the site area are certainly overestimates because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine.

Generally, 18 PCB congeners were detected in all eight blue mussel samples at concentrations of 36.97 ug/kg to 80.40 ug/kg (mean of 56.28 ug/kg). The reference blue mussel samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PCBs in site mussels. The concentrations of the PCBs in the reference mussel samples range from 27.20 ug/kg to 39.53 ug/kg (mean of 33.32

ug/kg), and are generally lower than those detected at the site. Although there is little uncertainty that the PCB concentrations in mussels at the site are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

With regard to toxicity, the potential risks may be overstated since the oral reference dose is based on Aroclor-1254 and is applied to all PCB congeners. With regard to exposure assumptions, the estimated noncancer risks for ingestion of PCBs in mussels may be overstated given the roughly 4-fold difference in the quahog ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the oyster ingestion rate, which is based on survey data presented in EPA (1990a). Ingestion rates for mussels were not provided in the Narragansett Bay Project (n.d.) or EPA (1990a).

Lobster

In lobster, arsenic was detected in all eight samples at a range of 2.27 mg/kg to 4.01 mg/kg (mean of 3.11 mg/kg). The reference lobster samples (locations JPC-1 and CHC-1) are used to evaluate the levels of arsenic in site lobster. The concentrations of the arsenic in the reference lobster samples range from 2.72 mg/kg to 3.04 mg/kg (mean of 2.88 mg/kg), and are within the range of those detected at the site. For this reason, the noncancer risks estimated for arsenic in lobster at the site are more likely to be bay-related rather than site-related.

With regard to toxicity, there is little uncertainty associated with the oral reference dose for arsenic since it is based on long-term exposures of humans to arsenic in drinking water. Additionally, arsenic risks at the site were based on EPA's oral reference dose. However, this toxicity factor was based on studies performed using arsenic trioxide (As_2O_3). However, arsenic in seafood exists in an organic state known as arsenobetaine. Approximately 80 to 90 percent of the arsenic available in seafood is in the organic form, which is not toxic (taken from Guidance Document for Arsenic in Shellfish, USFDA, January 1993). Therefore, the levels of risk estimated for arsenic in seafood in the site area are certainly overestimates because they are not based on toxicity values for arsenobetaine, but rather on inorganic arsenic, which has been demonstrated to be much more toxic than arsenobetaine.

With regard to exposure assumptions, the estimated cancer risks for ingestion of arsenic in lobsters may be overstated given the roughly 4-fold difference in the quahog ingestion rate, which is based on an estimate of seafood serving sizes and Rhode Island survey information (both provided by RIDEM in Narragansett Bay Project (n.d.)) and the oyster ingestion rate, which is based on survey data presented in EPA (1990a). Ingestion rates for lobsters were not provided by the Narragansett Bay Project (n.d.) or EPA (1990a).

Generally, 18 PCB congeners were detected in all nine lobster samples at concentrations of 20.34 ug/kg to 60.24 ug/kg (mean of 38.78 ug/kg). The reference lobster samples (locations JPC-1 and CHC-1) are used to evaluate the levels of PCB in site lobster. The concentrations of the PCBs in the reference lobster samples range from 27.80 ug/kg to 32.27 ug/kg (mean of 30.1 ug/kg), and are generally within or lower than those detected at the site. Although there is little uncertainty that the PCB concentrations in lobsters at the site are elevated relative to reference samples, other sources (localized variations in background, other point/non-point sources) may have contributed to the detected levels.

With regard to toxicity, the potential risks may be overstated since the oral reference dose is based on Aroclor-1254 and is applied to all PCB congeners.

7.4.3 Uncertainties Associated with the Estimated Blood Lead Concentrations

Lead was determined to be a potential concern at RME levels detected in hard shell clams and blue mussels for residential children, and in blue mussels for adult subsistence fishermen.

Hard Shell Clams

In hard shell clams, lead was detected in 7 of 11 samples at a range of 0.23 mg/kg to 0.42 mg/kg (mean of 0.19 mg/kg). The reference clam samples (locations JPC-1 and CHC-1) are used to evaluate the levels of lead in site clams. The concentrations of lead in the reference clam samples range from 0.30 mg/kg to 0.33 mg/kg (mean of 0.32 mg/kg), and are within the range of those detected at the site. For this reason the blood lead levels estimated for residential children and fetal blood lead in adult subsistence fishermen from lead in hard shell clams at the site may be bay-related rather than site-related. With regard to the estimated blood lead levels, a key

uncertainty in using EPA's IEUBK lead model for site shellfish is the ingestion rate for subsistence fisherman and percentage of shellfish ingestion to total ingestion for residential children.

Blue Mussels

In blue mussels, lead was detected in four of eight samples at a range of 0.25 mg/kg to 0.81 mg/kg (mean of 0.23 mg/kg). The reference blue mussel samples (locations JPC-1 and CHC-1) are used to evaluate the levels of lead in site clams. The concentrations of lead in the reference blue mussel samples range from 0.11 mg/kg to 0.46 mg/kg (mean of 0.28 mg/kg), and are within the range of those detected at the site. For this reason, the blood lead levels estimated for residential children and fetal blood lead in adult subsistence fishermen from lead in blue mussels at the site may be bay-related rather than site-related. With regard to the estimated blood lead levels, a key uncertainty in using EPA's IEUBK lead model for site shellfish is the ingestion rate for subsistence fisherman and percentage of shellfish ingestion to total ingestion for residential children.

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APPENDIX A

CHEMICAL DATA FOR SHELLFISH SAMPLES COLLECTED

OFFSHORE AREAS OF THE FORMER DERECKTOR SHIPYARD

Shellfish Data
Notes

The data used for the characterization of risk is presented on the following tables. Each table set is specific to each species, and describes the contaminants detected in representative individuals of that species for each sample station. Species are abbreviated in the table headers as described below:

IBM - Indigenous Blue Mussels

LOB - Lobster (Muscle tissue only, hepatopancreas {tamali} was not analyzed)

PM - *Pitar morrhuana,* a species of hard clam

MM - *Mercenaria mercenaria,* a second species of hard clam

Many of the concentrations are qualified from validation as follows:

ND - Actual concentration was not detected. Value provided is the detection limit calculated for that sample.

NC - Concentration could not be calculated

J - Quantification is estimated

I - Interference in the sample matrix did not allow quantification of the analyte

Z - Value is calculated

Concentrations are provided in units of mg/kg (for metals) and ug/kg (for organic compounds).

ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	CHC-1-IBM		CHC-1-LOB		DSY-24-IBM		DSY-25-IBM		DSY-25-LOB		DSY-26-IBM		DSY-27-IBM		DSY-27-LOB		DSY-28-IBM
Sample Location	CHC-1		CHC-1		DSY-24		DSY-25		DSY-25		DSY-26		DSY-27		DSY-27		DSY-28
Date Sampled																	
Description																	
Matrix	Mussels		Lobster		Mussels		Mussels		Lobster		Mussels		Mussels		Lobster		Mussels
Polyaromatic Hydrocarbons (PAH) (ng/g)																	
1,6,7-Trimethylnaphthalene	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	2.68247		0.5257	U	0.5257
1-Methylnaphthalene	0.7938	U	0.7938	U		I	2.081548		0.7938	U	0.7938	U	0.7938	U	0.738402	J	0.7938
1-Methylphenanthrene	1.267	U	11.448136		1.192254	J	3.640532		1.267	U	5.087166		6.9643		6.245134		1.267
2,6-Dimethylnaphthalene	3.10198		0.735	U	6.142234		1.9327		0.735	U	2.252278		3.458546		0.735	U	0.735
2-Methylnaphthalene	1.316	U	1.316	U		I	3.930346		1.316	U	1.316	U	1.316	U	1.07093	J	1.316
Acenaphthene	0.371	U	0.371	U	0.371	U	2.19268		0.371	U	0.371	U	0.371	U	4.555992		0.371
Acenaphthylene	2.44552		0.4039	U	1.611134		10.430126		0.4039	U	12.531904		8.275666		0.4039	U	4.869424
Anthracene	3.51316		0.890638	J	2.481598		25.745986		1.12	U	33.190906		23.347674		1.148714	J	9.546054
Benzo(a)anthracene	6.62354		0.4704	U	2.135588		39.272366		0.4704	U	145.61148		40.559778		4.060714		10.047338
Benzo(a)pyrene	4.339314		0.5061	U	1.107246		16.033346		0.5061	U	76.726482		10.234532		4.021598		4.739798
Benzo(b,j,k)fluoranthene	15.347976		0.868	U	6.06151		77.188664		0.868	U	323.4		55.024144		8.534512		17.862866
Benzo(e)pyrene	12.055792		0.546	U	5.171684		38.427928		0.546	U	114.800812		32.73739		2.80133		15.105524
Benzo(g,h,i)perylene	4.255692		0.2177	U	2.917768		6.728148		0.2177	U	20.665694		4.087888		1.149638		0.2177
Biphenyl	0.798	U	0.798	U	0.798	U	1.628088		0.798	U	0.798	U	1.805272		0.798	U	0.798
Chrysene	6.928936		0.7364	U	2.906848		42.163618		0.7364	U	87.612014		41.610198		4.31011		12.024082
Dibenz(a,h)anthracene	0.0686	U	0.0686	U	1.109192		1.895152		0.0686	U	6.954248		0.0686	U	0.0686	U	0.0686
Fluoranthene	11.884656		2.024316	J	8.251222		103.680192		14.06818		183.4		162.4		12.105086		34.41011
Fluorene	2.338336		0.273	U	0.963844		4.15702		0.273	U	4.672136		5.480636		0.273	U	3.520272
High Molecular Weight PAHs	40.190136	Z	6.545546	Z	22.262744	Z	273.757218	Z	27.83949	Z	645.904238	Z	369.525898	Z	37.69906	Z	85.83736
Indeno(1,2,3-cd)pyrene	2.17168		0.2156	U	1.66173		4.965114		0.2156	U	16.929542		3.749564		1.209082		0.2156
Low Molecular Weight PAHs	14.281036	Z	5.512752	Z	8.774444	Z	86.67673	Z	5.0421	Z	109.454016	Z	77.173264	Z	11.942756	Z	35.822654
Naphthalene	0.2352	U	0.2352	U		I	18.999862		0.2352	U	25.638774		0.2352	U	1.67993		0.2352
Perylene		I	0.49	U		I	11.474568		0.49	U	25.784304			I	1.510824		
Phenanthrene	4.061834		2.023014	J	3.346868		21.220724		1.323	U	31.733282		38.147088		2.810304		15.964718
Pyrene	10.34509		2.73973		6.752648		70.71253		11.989824		145.6		114.652776		13.132952		24.547432
Total Polycyclic Aromatic Hydrocarbons	89.413492	Z	19.18	Z	53.813368	Z	508.2	Z	26.04	Z	1262.8	Z	555.8	Z	71.12	Z	152.6
PCB Congener (ng/g)																	
101 (2 2'3 5 5')	2.32316		2.48514		3.8948		3.55516		1.16634		5.78046		7.94962		1.6079		5.68162
105 (2 3 3'4 4')	0.48076	J	0.786408	J	0.663404	J	0.554806	J	1.024982	J	1.014804	J	1.3489		13.4008		0.8988
118 (2 3'4 4'5)	2.706592		1.56282		2.943052		2.690212		5.180266		4.14386		6.236454		7.249942		3.67934
128 (2 2'3 3'4 4')	1.851458		1.105342		2.021866		1.112342		0.651966		2.294614		2.732982		1.049566		1.620584
138 (2 2'3 4 4'5)	4.46908		2.091096		8.464008		6.560022		5.009928		12.27758		17.610152		6.47213		11.746308
153 (2 2'4 4'5 5')	6.73092		3.094574		12.815838		9.772742		8.17635		17.445442		24.198342		9.214366		16.672782
170 (2 2'3 3'4 4'5)	0.261128		0.575904		0.66073		0.223468		0.916804		0.36057		0.638988		1.00975		0.523852
18 (2 2'5)	0.455	U	8.097852		0.392784	J	0.455	U	0.455	U	0.382424	J	0.874412	J	0.312928	J	0.455

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	CHC-1-IBM		CHC-1-LOB		DSY-24-IBM		DSY-25-IBM		DSY-25-LOB		DSY-26-IBM		DSY-27-IBM		DSY-27-LOB		DSY-28-IBM
Sample Location	CHC-1		CHC-1		DSY-24		DSY-25		DSY-25		DSY-26		DSY-27		DSY-27		DSY-28
Date Sampled																	
Description																	
Matrix	Mussels		Lobster		Mussels		Mussels		Lobster		Mussels		Mussels		Lobster		Mussels
180 (2 2'3 4 4'5 5')	0.679154		0.54922		1.639092		1.175244		2.102912		1.692278		3.865484		2.642136		2.364068
187 (2 2'3 4'5 5'6)	1.9635		4.412604		4.083856		3.309166		2.129694		5.69072		7.802774		2.536744		5.314624
195 (2 2'3 3'4 4'5 6)	0.176428		0.056	U	0.056	U	0.165172		0.224686		0.056	U	0.131698		0.372974		0.41608
206 (2 2'3 3'4 4'5 5'6)	0.532756		2.380112		0.44093		0.275884		0.821436		0.767886		0.31409		0.63042		0.50883
209 (2 2'3 3'4 4'5 5'6 6')	0.61565		0.1008	U	0.657594		0.21483		0.52416		0.579712		0.08883	J	0.484834		1.162056
28 (2 4 4')	2.294824		2.881396		0.809648		1.991934		1.271326		2.293914		1.42149		1.0171		1.38474
44 (2 2'3 5')	0.0532	U	0.0532	U	0.937132		0.776412		0.72807		1.12217		1.547308		0.365988		0.83258
52 (2 2'5 5)	1.78962		1.604288		1.635494		2.97556		1.057126		1.992564		2.778874		1.3461		3.059574
66 (2 3'4 4')	0.5397	U	0.642908	J	0.5397	U	0.576996	J	1.76526		0.5397	U	0.5397	U	2.117444		0.5397
8 (2 4)	0.328076	J	0.329	U	1.021076		1.049426		0.329	U	0.346752	J	0.859754		0.531468	J	0.263424
PCB Sum of Congeners	27.203092		32.269664		43.081304		36.97939		32.751334		58.18575		80.40018		52.362576		56.129206
PCB Sum of Congeners x 2	54.406198	Z	64.539328	Z	86.162594	Z	73.95878	Z	65.502654	Z	116.371514	Z	161	Z	104.725152	Z	112.258426
Butyltins (ng Sn/g)																	
Dibutyltin	2.1378		0.42	U	0.42	U	0.42	U	0.42	U	0.42	U	5.7232		0.42	U	0.42
Monobutyltin	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49
Tetrabutyltin	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35
Tributyltin	9.3184		0.42	U	1.8928		3.5056		0.42	U	2.7832		136.7814		0.42	U	6.8712
Metals (ug/g)																	
Aluminum	8.3468		0.007	U	20.4022		7.8694		0.007	U	25.4716		52.1668		4.35456		14.903
Arsenic	0.6552		3.0352		1.4308		1.7584		4.0096		1.1508		0.9352		2.4066		0.3752
Cadmium	0.0812		0.0322		0.2604		0.1694		0.0504		0.1022		0.1078		0.0364		0.0868
Chromium	0.2576		0.2002		0.441		0.42		0.2324		0.3416		0.4004		0.2954		0.3556
Copper	1.6702		14.2688		0.5824		1.6716		21.2226		1.0766		2.086		23.3506		0.1582
Iron	26.9024		3.5588		61.2066		29.5148		5.6378		42.126		51.674		11.4296		15.092
Lead	0.1092		0.0252		0.8134		0.000042	U	0.02198		0.000042	U	0.4228		0.00966		0.000042
Manganese	0.6972			NA	2.4276		1.5736		0.3584		0.7826		4.4576		0.1946		5.3648
Mercury	0.025802		0.031934		0.039088		0.024444		0.036792		0.016576		0.020706		0.06356		0.020202
Nickel	0.5376		0.2198		0.7616		0.4802		0.2128		0.000042	U	0.6636		0.168		0.000042
Silver	0.000014	U	0.5376		0.000014	U	0.000014	U	0.7658		0.000014	U	0.000014	U	0.9618		0.000014
Zinc	12.8352		16.6572		10.6862		15.7402		12.3018		12.7358		19.9178		15.785		16.891

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number		DSY-28-LOB		DSY-29-LOB		DSY-31-PM		DSY-32-PM		DSY-33-LOB		DSY-33-PM		DSY-34-PM	
Sample Location		DSY-28		DSY-29		DSY-31		DSY-32		DSY-33		DSY-33		DSY-34	
Date Sampled															
Description															
Matrix		Lobster		Lobster		Hard Clam		Hard Clam		Lobster		Hard Clam		Hard Clam	
Polyaromatic Hydrocarbons (PAH) (ng/g)															
1,6,7-Trimethylnaphthalene	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U
1-Methylnaphthalene	U	1.856442		1.378832	J	0.7938	U	0.7938	U	1.62113		0.7938	U	0.7938	U
1-Methylphenanthrene	U	11.720968		11.036494			I	8.508948		12.166952		22.188978		17.541104	
2,6-Dimethylnaphthalene	U	1.758554		0.735	U	0.735	U	0.735	U	0.735	U	0.735	U	0.735	U
2-Methylnaphthalene	U	1.718654	J	2.083774	J	1.316	U	1.316	U	1.927618	J	1.316	U	1.316	U
Acenaphthene	U	0.371	U	0.371	U	0.371	U	0.371	U	0.371	U	0.395948	J	0.371	U
Acenaphthylene		0.4039	U	0.4039	U	0.4039	U	1.892618		0.4039	U	0.4039	U	0.4039	U
Anthracene		0.581434	J	1.12	U	4.250022		3.854858		1.12	U	1.871198	J	2.774548	
Benzo(a)anthracene		3.401902		0.4704	U	18.6032		11.089498		0.4704	U	4.934468		6.46044	
Benzo(a)pyrene		3.493014		1.831956		6.298936		5.963398		0.5061	U	3.106544		3.142202	
Benzo(b,j,k)fluoranthene		8.17215		3.310454		18.0348		13.212472		3.21538		4.9826		6.81163	
Benzo(e)pyrene		2.817038		1.35226		0.546	U	0.546	U	1.663956		0.546	U	0.546	U
Benzo(g,h,i)perylene	U	1.639974		1.773366		3.607394		4.79108		0.2177	U	1.855518		1.56786	
Biphenyl	U	1.131382	J	0.798	U	0.798	U	0.798	U	1.9929		0.798	U	0.798	U
Chrysene		5.402124		0.7364	U	9.4318		8.362186		0.7364	U	5.91766		3.419248	
Dibenz(a,h)anthracene	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U
Fluoranthene		10.205524		5.464074		25.004756		21.3185		4.500188		8.002582		10.274502	
Fluorene		0.273	U	2.088296		0.273	U	0.273	U	0.273	U	0.725928		0.72989	
High Molecular Weight PAHs	Z	39.873568	Z	18.299344	Z	87.008362	Z	72.244662	Z	13.721064	Z	29.823612	Z	34.208622	Z
Indeno(1,2,3-cd)pyrene	U	0.2156	U	1.47945		2.859598		3.761744		0.2156	U	1.229872		1.105188	
Low Molecular Weight PAHs	Z	9.52959	Z	12.730298	Z	10.180688	Z	11.968292	Z	11.801692	Z	6.95184	Z	10.750236	Z
Naphthalene	U	1.680084		2.719248		0.2352	U	0.2352	U	4.928602		0.2352	U	0.2352	U
Perylene	I	1.664684		0.49	U		I	1.447138		0.49	U	0.7441	J	0.547372	J
Phenanthrene		4.501532		3.94408		3.331566		4.025602		2.777572		2.003666	J	4.919684	
Pyrene		17.302404		9.727914		27.601056		25.44248		7.439376		7.793758		10.843644	
Total Polycyclic Aromatic Hydrocarbons	Z	79.1	Z	48.16	Z	119	Z	113.68	Z	42.28	Z	65.8	Z	70.14	Z
PCB Congener (ng/g)															
101 (2 2'3 5 5')		1.63324		1.3041		3.0289		2.26352		1.49506		2.73546		1.0703	
105 (2 3 3'4 4')	J	5.07003		0.462714	J	34.219528		1.493716		5.84458		4.81803		1.504972	
118 (2 3'4 4'5)		9.650522		2.084726		2.581096		1.894578		3.089282		2.203614		0.812784	
128 (2 2'3 3'4 4')		1.734278		0.495264		0.653898		0.492212		0.597184		0.495446		0.210252	
138 (2 2'3 4 4'5)		9.965172		3.62712		5.152658		3.716398		4.553738		4.755576		2.607528	
153 (2 2'4 4'5 5')		13.87477		4.961474		7.328412		5.287898		6.58854		7.28903		3.300976	
170 (2 2'3 3'4 4'5)		1.71143		0.91245		0.802074		0.86821		0.772212		1.078854		0.756266	
18 (2 2'5)	U	0.494858	J	0.57799	J	0.382102	J	0.455	U	0.174034	J	0.455	U	0.455	U

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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number		DSY-28-LOB		DSY-29-LOB		DSY-31-PM		DSY-32-PM		DSY-33-LOB		DSY-33-PM		DSY-34-PM	
Sample Location		DSY-28		DSY-29		DSY-31		DSY-32		DSY-33		DSY-33		DSY-34	
Date Sampled															
Description															
Matrix		Lobster		Lobster		Hard Clam		Hard Clam		Lobster		Hard Clam		Hard Clam	
180 (2 2'3 4 4'5 5')		4.793432		1.988518		2.56214		1.995168		2.056138		2.804844		1.91289	
187 (2 2'3 4'5 5'6)		4.409538		1.908592		2.27178		1.790684		1.982876		2.4451		1.482376	
195 (2 2'3 3'4 4'5 6)		0.656516		0.600908		0.320166		0.20699		0.575176		0.567336		0.244958	
206 (2 2'3 3'4 4'5 5'6)		0.9758		0.888314		1.097082		0.701218		0.903826		0.902748		0.896854	
209 (2 2'3 3'4 4'5 5'6 6')		0.58275		0.798882		0.902286		0.645526		0.610792		0.724738		0.92421	
28 (2 4 4')		0.632366		0.899766		1.647506		1.747424		0.53081		1.542086		3.372292	
44 (2 2'3 5')		0.057204	J	0.047642	J	0.537782		0.0532	U	0.68901		1.65011		1.032402	
52 (2 2'5 5)		1.293978		1.71157		1.26399		1.135904		0.673512		0.939974		0.701442	
66 (2 3'4 4')	U	2.12989		1.590806		1.784426		1.485232		1.443414		1.70884		0.96761	J
8 (2 4)	J	0.572194	J	0.329	U	0.329	U	0.329	U	0.255808	J	0.329	U	0.329	U
PCB Sum of Congeners		60.237954		24.86085		66.535882		25.724664		32.835978		36.661786		21.798098	
PCB Sum of Congeners x 2	Z	120.475908	Z	49.7217	Z	133.07175	Z	51.449342	Z	65.671956	Z	73.323558	Z	43.59621	Z
Butyltins (ng Sn/g)															
Dibutyltin	U	0.42	U	0.42	U	0.42	U		NA	0.42	U	0.42	U	0.42	U
Monobutyltin	U	0.49	U	0.49	U	0.49	U		NA	0.49	U	0.49	U	0.49	U
Tetrabutyltin	U	0.35	U	0.35	U	0.35	U		NA	0.35	U	0.35	U	0.35	U
Tributyltin		0.42	U	0.42	U	6.7074			NA	0.42	U	7.532		5.495	
Metals (ug/g)															
Aluminum		0.007	U	0.007	U	7.7014		3.2158		0.54516		11.8468		9.9932	
Arsenic			NA	3.9984		1.3104		0.6888		3.115		0.8232		1.2068	
Cadmium			NA	0.0658		0.1092		0.0826		0.0224		0.0924		0.0994	
Chromium			NA	0.2394		0.2772		0.2436		0.2786		0.259		0.2982	
Copper			NA	14.0532		2.0132		1.5288		8.449		1.2096		1.4196	
Iron		4.8104		3.9172		23.0328		24.9018		4.361		26.7246		28.2268	
Lead	U		NA	0.0308		0.2436		0.3878		0.0658		0.000042	U	0.2324	
Manganese			NA	0.2436		1.6002		2.2288		0.4354		1.7808		2.1854	
Mercury			NA	0.040236		0.019082		0.021686		0.031766		0.017234		0.016646	
Nickel	U		NA	0.2436		0.5586		0.3038		0.2436		0.000042	U	0.2954	
Silver	U		NA	0.8176		0.000014	U	0.1932		0.4802		0.000014	U	0.000014	U
Zinc			NA	18.1174		12.2276		15.7528		14.7196		14.2422		12.9388	

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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-35-IBM		DSY-35-LOB		DSY-35-MM		DSY-35-PM		DSY-36-IBM		DSY-36-LOB		DSY-36-PM		DSY-37-PM	
Sample Location	DSY-35		DSY-35		DSY-35		DSY-35		DSY-36		DSY-36		DSY-36		DSY-37	
Date Sampled																
Description																
Matrix	Mussels		Lobster		Hard Clam		Hard Clam		Mussels		Lobster		Hard Clam		Hard Clam	
Polyaromatic Hydrocarbons (PAH) (ng/g)																
1,6,7-Trimethylnaphthalene	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U
1-Methylnaphthalene	0.7938	U		I	0.7938	U	0.7938	U		I		I	0.7938	U		I
1-Methylphenanthrene	1.38509	J	1.267	U	0.600082	J	6.592642		0.950124	J	1.267	U	16.831472		1.267	U
2,6-Dimethylnaphthalene	2.695406		0.735	U	0.735	U	0.735	U	0.638232	J	0.735	U	0.735	U	0.735	U
2-Methylnaphthalene	1.316	U		I	1.316	U	1.316	U		I		I	1.316	U		I
Acenaphthene	0.371	U	0.371	U	0.371	U	0.371	U	0.371	U	0.371	U	0.371	U	0.371	U
Acenaphthylene	0.4039	U	0.4039	U	0.4039	U	0.4039	U	2.141664		0.4039	U	0.4039	U	0.4039	U
Anthracene	3.566794		0.43491	J	1.12	U	0.924546	J	4.059566		0.741174	J	4.197074		1.41995	J
Benzo(a)anthracene	4.3554		0.4704	U	2.200786		3.01427		4.236092		0.4704	U	9.267272		7.837886	
Benzo(a)pyrene	0.5061	U	0.5061	U	0.975982	J	2.260664		1.754298		0.5061	U	4.524296		3.239334	
Benzo(b,j,k)fluoranthene	9.244662		0.868	U	1.284066	J	2.291408		9.933		4.307394		12.687206		8.131186	
Benzo(e)pyrene	7.316372		0.546	U	0.253288	J	0.518154	J	6.799114		0.546	U	0.546	U	1.147734	
Benzo(g,h,i)perylene	1.980468		0.2177	U	0.2177	U	0.2177	U	1.40798		0.2177	U	2.04631		3.688734	
Biphenyl	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U
Chrysene	5.633712		0.7364	U	0.954226	J	1.565606		5.67336		0.7364	U	7.173082		5.26834	
Dibenz(a,h)anthracene	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U
Fluoranthene	14.67585		4.603634		6.650868		9.69549		14.715358		5.41086		17.405388		10.470082	
Fluorene	1.626128		0.273	U	0.405118	J	0.768586		0.70112		0.273	U	0.273	U	0.273	U
High Molecular Weight PAHs	36.237586	Z	9.827832	Z	15.827714	Z	24.293108	Z	38.388308	Z	13.232184	Z	54.628322	Z	38.528546	Z
Indeno(1,2,3-cd)pyrene	1.453214		0.2156	U	0.2156	U	0.2156	U	0.838754		0.2156	U	1.524628		0.2156	U
Low Molecular Weight PAHs	13.357918	Z	3.329802	Z	6.448358	Z	7.97986	Z	11.237366	Z	4.384968	Z	11.232816	Z	6.302898	Z
Naphthalene	0.2352	U		I	0.2352	U	0.2352	U		I		I	0.2352	U		I
Perylene		I	0.49	U	1.764966		2.257962			I	0.49	U	2.320556		3.585932	
Phenanthrene	5.838896		1.846992	J	2.59714	J	3.960628		3.964016		2.595908	J	4.436642		3.835048	
Pyrene	10.997924		3.442698		4.977252		7.688464		11.940586		6.03981		16.189684		11.644304	
Total Polycyclic Aromatic Hydrocarbons	70.76993	Z	10.36	Z	22.68	Z	41.58	Z	69.753278	Z	19.04	Z	98.56	Z	60.2	Z
PCB Congener (ng/g)																
101 (2 2'3 5 5')	4.84932		0.73038		0.74634		2.61898		5.58544		1.75574		1.91394		1.6947	
105 (2 3 3'4 4')	0.847098	J	0.53592	J	0.271908	J	0.5726	U	0.893508	J	29.20855		1.234884		0.718886	J
118 (2 3'4 4'5)	3.712688		1.944586		0.558264	J	1.996246		4.09248		4.6683		1.97771		1.561686	
128 (2 2'3 3'4 4')	2.835504		0.342692		0.137634	J	0.915642		2.78138		0.822654		0.679672		0.711858	
138 (2 2'3 4 4'5)	10.32948		2.974902		1.10957		5.359368		14.04137		5.35549		6.621356		5.581856	
153 (2 2'4 4'5 5')	14.514458		4.28239		2.398032		7.432852		20.21537		6.43328		7.062888		7.864682	
170 (2 2'3 3'4 4'5)	0.23828		0.719054		0.676438		0.927766		0.504224		1.112874		0.95193		1.034516	
18 (2 2'5)	0.455	U	1.501584		0.455	U	0.455	U	0.455	U	0.455	U	0.42161	J	0.231756	J

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-35-IBM		DSY-35-LOB		DSY-35-MM		DSY-35-PM		DSY-36-IBM		DSY-36-LOB		DSY-36-PM		DSY-37-PM	
Sample Location	DSY-35		DSY-35		DSY-35		DSY-35		DSY-36		DSY-36		DSY-36		DSY-37	
Date Sampled																
Description																
Matrix	Mussels		Lobster		Hard Clam		Hard Clam		Mussels		Lobster		Hard Clam		Hard Clam	
180 (2 2'3 4 4'5 5')	1.576274		1.480612		1.585262		2.626526		2.4521		2.095702		3.313016		3.66338	
187 (2 2'3 4'5 5'6)	5.179482		1.428994		0.933744		2.815204		6.722758		1.730414		2.829862		2.872072	
195 (2 2'3 3'4 4'5 6)	0.056	U	0.280588		0.149968		0.425572		0.056	U	0.354746		0.14441		0.437332	
206 (2 2'3 3'4 4'5 5'6)	0.360206		0.50477		0.682136		1.019018		0.408548		0.678314		1.131102		0.58275	
209 (2 2'3 3'4 4'5 5'6 6')	0.370412		0.429128		0.354984		0.868154		0.466438		0.636874		1.380484		0.71155	
28 (2 4 4')	1.258488		0.758534		0.177254	J	2.915542		1.233736		0.560826		0.147322	J	0.352254	J
44 (2 2'3 5')	0.877296		1.21184		0.089866	J	0.161966		0.969318		0.866628		0.564102		0.114408	
52 (2 2'5 5)	1.466556		1.058302		0.392784	J	1.626184		1.794688		1.013026		0.984284		0.361354	J
66 (2 3'4 4')	0.5397	U	0.95249	J	0.890484	J	2.177616		0.5397	U	1.48638		3.124912		1.420734	
8 (2 4)	0.307244	J	1.019844			I	0.329	U	0.46557	J	0.329	U	0.329	U		NC
PCB Sum of Congeners	48.722772		22.156596		11.154668		33.886636		62.626942		58.779812		34.483498		29.915746	
PCB Sum of Congeners x 2	97.445544	Z	44.313206	Z	22.309322	Z	67.773258	Z	125.253884	Z	117.55961	Z	68.966996	Z	59.831506	Z
Butyltins (ng Sn/g)																
Dibutyltin	0.42	U	0.42	U	0.42	U		NA	0.42	U	0.42	U	0.42	U		NA
Monobutyltin	0.49	U	0.49	U	0.49	U		NA	0.49	U	0.49	U	0.49	U		NA
Tetrabutyltin	0.35	U	0.35	U	0.35	U		NA	0.35	U	0.35	U	0.35	U		NA
Tributyltin	1.2852		0.42	U	5.474			NA	4.9672		0.42	U	9.3996			NA
Metals (ug/g)																
Aluminum	11.459		0.007	U	13.2132		9.051		11.8384		1.4644		6.0144		10.3348	
Arsenic	0.8722		2.2722		0.8988		1.1858		0.861		2.7776		1.0402		1.0402	
Cadmium	0.1022		0.0784		0.0896		0.0924		0.0546		0.000042	U	0.1162		0.0896	
Chromium	0.3108		0.3024		0.3332		0.2814		0.3976		0.2758		0.3444		0.2422	
Copper	1.05		17.9746		0.8988		1.1802		0.9856		6.8824		1.6744		1.2502	
Iron	28.6482		5.649		35.9408		17.3096		27.6248		5.8576		24.5616		17.073	
Lead	0.245		0.1064		0.000042	U	0.2324		0.000042	U	0.0476		0.3052		0.4158	
Manganese	0.3808		0.3584		1.6268		2.7902		1.5778			NA	1.5176		1.4616	
Mercury	0.023226		0.03724		0.016954		0.014028		0.026418		0.045906		0.020986		0.021546	
Nickel	0.000042	U	0.1274		0.4088		0.217		0.6062		0.2044		0.2618		0.2198	
Silver	0.000014	U	0.9156		0.000014	U	0.000014	U	0.000014	U	0.4018		0.000014	U	0.091	
Zinc	18.144		15.407		15.519		17.4636		11.8384		16.1084		16.9176		14.8624	

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-38-LOB		DSY-38-PM		DSY-39-LOB		DSY-40-IBM	
Sample Location	DSY-38		DSY-38		DSY-39		DSY-40	
Date Sampled								
Description								
Matrix	Lobster		Hard Clam		Lobster		Mussels	
Polyaromatic Hydrocarbons (PAH) (ng/g)								
1,6,7-Trimethylnaphthalene	0.5257	U	0.5257	U	0.5257	U	0.5257	U
1-Methylnaphthalene	0.7938	U	0.7938	U	0.7938	U	0.7938	U
1-Methylphenanthrene	1.267	U	10.573318		1.267	U	1.267	U
2,6-Dimethylnaphthalene	0.735	U	0.735	U	0.735	U	0.735	U
2-Methylnaphthalene	1.316	U	1.316	U	1.316	U	1.316	U
Acenaphthene	0.371	U	0.781438		0.371	U	0.371	U
Acenaphthylene	0.4039	U	0.756098	J	0.4039	U	3.169992	
Anthracene	0.39704	J	1.49205	J	0.251986	J	4.780734	
Benzo(a)anthracene	0.4704	U	6.397608		0.4704	U	3.455662	
Benzo(a)pyrene	0.5061	U	2.893856		0.5061	U	0.873012	J
Benzo(b,j,k)fluoranthene	0.868	U	5.669244		0.868	U	7.765282	
Benzo(e)pyrene	0.546	U	0.546	U	0.546	U	6.580014	
Benzo(g,h,i)perylene	0.2177	U	1.795612		0.2177	U	0.2177	U
Biphenyl	0.798	U	0.798	U	0.798	U	0.798	U
Chrysene	0.7364	U	3.915296		0.7364	U	4.128558	
Dibenz(a,h)anthracene	0.0686	U	0.0686	U	0.0686	U	0.0686	U
Fluoranthene	2.317364	J	6.08972		1.292704	J	14.762762	
Fluorene	0.273	U	0.663656		0.273	U	2.008118	
High Molecular Weight PAHs	5.36494	Z	25.420136	Z	4.55238	Z	34.694926	Z
Indeno(1,2,3-cd)pyrene	0.2156	U	1.281098		0.2156	U	0.2156	U
Low Molecular Weight PAHs	4.404582	Z	6.531448	Z	3.895444	Z	22.064224	Z
Naphthalene	0.2352	U	0.2352	U	0.2352	U	2.11106	
Perylene	0.49	U	0.567518	J	0.49	U		I
Phenanthrene	1.408456	J	1.287006	J	1.044358	J	8.30732	
Pyrene	1.266076		6.05507		1.478176		11.406332	
Total Polycyclic Aromatic Hydrocarbons	5.32	Z	50.26	Z	4.06	Z	69.348846	Z
PCB Congener (ng/g)								
101 (2 2'3 5 5')	1.00352			NC	5.23306		6.1775	
105 (2 3 3'4 4')	0.359814	J		NC	1.165626		1.107652	J
118 (2 3'4 4'5)	1.833734			NC	3.98398		4.919726	
128 (2 2'3 3'4 4')	0.320348			NC	0.778218		3.220644	
138 (2 2'3 4 4'5)	3.009454			NC	6.033832		13.74205	
153 (2 2'4 4'5 5')	4.512592			NC	8.442714		19.085752	
170 (2 2'3 3'4 4'5)	0.866908			NC	0.993076		0.500836	
18 (2 2'5)	0.455	U		NC	0.455	U	0.455	U

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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-38-LOB		DSY-38-PM		DSY-39-LOB		DSY-40-IBM	
Sample Location	DSY-38		DSY-38		DSY-39		DSY-40	
Date Sampled								
Description								
Matrix	Lobster		Hard Clam		Lobster		Mussels	
180 (2 2'3 4 4'5 5')	1.71311			NC	2.629578		2.730168	
187 (2 2'3 4'5 5'6)	1.38726			NC	2.40086		6.26339	
195 (2 2'3 3'4 4'5 6)	0.295106			NC	0.357364		0.39137	
206 (2 2'3 3'4 4'5 5'6)	0.532882			NC	1.00989		0.490784	
209 (2 2'3 3'4 4'5 5'6 6')	0.436688			NC	0.809424		0.580524	
28 (2 4 4')	0.598696			NC	5.711846		1.246868	
44 (2 2'3 5')	1.008966			NC	0.94493		1.111236	
52 (2 2'5 5)	0.733264			NC	1.83351		1.869322	
66 (2 3'4 4')	1.482124			NC	2.715174		0.5397	U
8 (2 4)	0.252042	J		NC	0.329	U	0.384272	J
PCB Sum of Congeners	20.346522			NA	45.043068		63.82208	
PCB Sum of Congeners x 2	40.693044	Z		Z	90.086136	Z	127.644174	Z
Butyltins (ng Sn/g)								
Dibutyltin	0.42	U		NA	0.42	U	0.42	U
Monobutyltin	0.49	U		NA	0.49	U	0.49	U
Tetrabutyltin	0.35	U		NA	0.35	U	0.35	U
Tributyltin	0.42	U		NA	0.42	U	4.438	
Metals (ug/g)								
Aluminum	0.007	U	13.4988		0.007	U	17.6218	
Arsenic	3.6512		0.8512		2.6124		0.7378	
Cadmium	0.0686		0.0826		0.042		0.0882	
Chromium	0.273		0.2576		0.2296		0.3122	
Copper	23.128		1.4616		27.5646		0.9786	
Iron	4.0838		22.4532		4.2406		41.118	
Lead	0.0364		0.000042	U	0.0252		0.3416	
Manganese	0.6118		2.2372		0.6356		2.1532	
Mercury	0.046046		0.023464		0.057456		0.023114	
Nickel	0.2632		0.000042	U	0.2044		0.000042	U
Silver	0.854		0.000014	U	0.1148		0.000014	U
Zinc	23.996		18.3876		18.0222		14.6846	

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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-41-MM		DSY-41-PM		JPC-1-LOB		JPC-1-MM		JPC-1-PM	
Sample Location	DSY-41		DSY-41		JPC-1		JPC-1		JPC-1	
Date Sampled										
Description										
Matrix	Hard Clam		Hard Clam		Lobster		Hard Clam		Hard Clam	
Polyaromatic Hydrocarbons (PAH) (ng/g)										
1,6,7-Trimethylnaphthalene	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U
1-Methylnaphthalene	0.7938	U	0.7938	U	0.7938	U	0.7938	U	0.7938	U
1-Methylphenanthrene	0.934906	J	10.73212		14.63812		4.14001		10.92364	
2,6-Dimethylnaphthalene	0.735	U	0.735	U	0.735	U	0.735	U	0.735	U
2-Methylnaphthalene	1.316	U	1.316	U	1.316	U	1.316	U	1.316	U
Acenaphthene	0.914564		0.902216		0.371	U	0.371	U	0.371	U
Acenaphthylene	0.638596	J	1.195082		0.4039	U	0.366632	J	0.424354	J
Anthracene	1.52754	J	2.75345		1.12	U	0.84833	J	0.860132	J
Benzo(a)anthracene		I	5.79516		0.4704	U	1.474004		3.706626	
Benzo(a)pyrene	1.55085		2.427992		0.5061	U	0.588056	J	1.120574	
Benzo(b,j,k)fluoranthene	1.856428		3.194632		0.868	U	0.86555	J	2.225734	
Benzo(e)pyrene	0.427448	J	0.420448	J	0.546	U	0.151564	J	0.275618	J
Benzo(g,h,i)perylene	0.51989		0.2177	U	0.2177	U	0.2177	U	0.2177	U
Biphenyl	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U
Chrysene		I	4.394166		0.7364	U	1.367226	J	2.43873	
Dibenz(a,h)anthracene	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U
Fluoranthene	9.589832		11.15807		1.42751	J	3.023328		3.61445	
Fluorene	0.535024	J	1.11321		1.757812		0.519568	J	0.44513	J
High Molecular Weight PAHs	20.374606	Z	35.487592	Z	4.896696	Z	9.536618	Z	15.319192	Z
Indeno(1,2,3-cd)pyrene	0.2156	U	0.2156	U	0.2156	U	0.2156	U	0.2156	U
Low Molecular Weight PAHs	7.030338	Z	9.804774	Z	7.379442	Z	4.480028	Z	4.834578	Z
Naphthalene	0.2352	U	0.2352	U	0.2352	U	0.2352	U	0.2352	U
Perylene	1.737232		1.891372		0.49	U	0.593908	J	0.58884	J
Phenanthrene	1.8634	J	2.289616	J	2.17553	J	0.823298	J	1.182762	J
Pyrene	9.165324		11.64359		1.6877		3.015418		4.370212	
Total Polycyclic Aromatic Hydrocarbons	31.22	Z	59.92	Z	21.7	Z	17.78	Z	32.2	Z
PCB Congener (ng/g)										
101 (2 2'3 5 5')	1.13988		1.06652		1.03684		0.8603		1.30074	
105 (2 3 3'4 4')	0.77035	J	0.5726	U	0.936124	J	0.197582	J	0.328762	J
118 (2 3'4 4'5)	1.154762		1.0269		1.929088		0.797972		1.05308	
128 (2 2'3 3'4 4')	0.612024		0.267694		0.780976		0.169106		0.14812	
138 (2 2'3 4 4'5)	2.07984		3.022656		3.002832		1.477938		3.147326	
153 (2 2'4 4'5 5')	3.16407		4.618138		4.389434		3.799824		4.33881	
170 (2 2'3 3'4 4'5)	1.568882		0.611436		1.110312		0.59731		0.627984	
18 (2 2'5)	0.455	U	0.140854	J	3.616452		0.455	U	0.139888	J

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-41-MM		DSY-41-PM		JPC-1-LOB		JPC-1-MM		JPC-1-PM	
Sample Location	DSY-41		DSY-41		JPC-1		JPC-1		JPC-1	
Date Sampled										
Description										
Matrix	Hard Clam		Hard Clam		Lobster		Hard Clam		Hard Clam	
180 (2 2'3 4 4'5 5')	1.810998		2.691528		1.477616		2.249534		1.904616	
187 (2 2'3 4'5 5'6)	1.049216		1.831074		2.841566		1.474816		1.512392	
195 (2 2'3 3'4 4'5 6)	0.152054		0.39788		0.056	U	0.066542	J	0.23849	
206 (2 2'3 3'4 4'5 5'6)	0.691936		0.615244		1.336762		0.411712		0.976206	
209 (2 2'3 3'4 4'5 5'6 6')	0.267904		0.479864		1.168258		0.395346		0.704424	
28 (2 4 4')	0.743848		0.037156	J	2.064132		0.26873	J	0.210378	J
44 (2 2'3 5')	0.284914		0.316008		0.29302		0.169806		0.28707	
52 (2 2'5 5)	0.52353	J	0.70329		0.853538		0.392798	J	0.486584	J
66 (2 3'4 4')	1.545796		1.36171		0.963956	J	0.97951	J	1.261316	
8 (2 4)		I	0.329	U	0.329	U		I	0.329	U
PCB Sum of Congeners	17.559976		19.187938		27.800934		14.30884		18.666186	
PCB Sum of Congeners x 2	35.119966	Z	38.375876	Z	55.601882	Z	28.617666	Z	37.332372	Z
Butyltins (ng Sn/g)										
Dibutyltin	0.42	U		NA	0.42	U	0.42	U	0.42	U
Monobutyltin	0.49	U		NA	0.49	U	0.49	U	0.49	U
Tetrabutyltin	0.35	U		NA	0.35	U	0.35	U	0.35	U
Tributyltin	4.2854			NA	0.42	U	1.869		6.937	
Metals (ug/g)										
Aluminum	14.1624		8.4014		0.007	U	15.2362		5.5468	
Arsenic	1.0444		0.3024		2.7202		1.0822		1.5456	
Cadmium	0.126		0.1008		0.0252		0.0994		0.0896	
Chromium	0.2464		0.2716		0.2352		0.2954		0.3024	
Copper	1.841		1.666		19.9766		0.9618		1.6758	
Iron	18.4114		15.2194		5.4166		20.9972		19.4488	
Lead	0.22512		0.000042	U	0.0546		0.2968		0.3318	
Manganese	1.911		1.7976		0.4368		2.4682		0.8568	
Mercury	0.01673		0.020902		0.041818		0.017962		0.015652	
Nickel	0.000042	U	0.2632		0.1946		0.1848		0.000042	U
Silver	0.1764		0.000014	U	0.3066		0.000014	U	0.000014	U
Zinc	9.205		11.7138		14.7868		16.2764		16.8896	

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX B

Toxicity Profiles for Constituents of Potential Concern

APPENDIX B

TOXICOLOGICAL PROFILES FOR CONSTITUENTS OF POTENTIAL CONCERN

B.1 Inorganics

Aluminum

Aluminum is one of the most abundant metals in the earth's crust, and it is ubiquitous in air, water and soil (Goyer, 1986). The toxicity of aluminum can be divided into three major categories: (1) the effect of aluminum constituents on the gastrointestinal tract; (2) the effect of inhalation of aluminum constituents; and (3) systemic toxicity of aluminum. Aluminum constituents can alter absorption of other elements in the gastrointestinal tract (i.e., fluoride, calcium, iron, cholesterol, phosphorus) and alter gastrointestinal tract motility by inhibition of acetylcholine-induced contractions. Inhalation of aluminum dusts can lead to the development of pulmonary fibrosis producing both restrictive and obstructive pulmonary disease. A progressive fatal neurologic syndrome has been noted in patients on long-term intermittent hemodialysis treatment for chronic renal failure and may be due to aluminum intoxication. Symptoms in these patients include a speech disorder followed by dementia, convulsions and myoclonus. Aluminum content of brain, muscle and bone tissues is increased in these patients. Sources of the excess aluminum may be from oral aluminum hydroxide commonly given to these patients or from aluminum in dialysis fluid derived from tap water used to prepare the dialysate fluid.

The available data have been evaluated and found to be inadequate for quantitative non-cancer risk assessment (EPA, 1993a, 1994a). EPA (1993a, 1994a) has not evaluated aluminum with regard to its potential human carcinogenicity.

Antimony

The best characterized human health effect associated with the inhalation of antimony is myocardial damage. The suggested no-observed-adverse-effect-level (NOAEL) for antimony induced myocardial damage is 3E-04 mg antimony/kg body weight (bw)/day (mg/kg-d).

The chronic oral RfD for antimony is 4E-04 mg/kg-d (EPA, 1994a), and is based on a chronic rat bioassay. Rats were administered 5 ppm (0.35 mg/kg bw/day) potassium antimony tartrate in drinking water for two years. The critical effects associated with this study are a decrease in longevity, a decrease in fasting blood glucose levels and an alteration in cholesterol levels. An uncertainty factor of 1,000 was applied to the lowest observed adverse effect level (LOAEL) of 0.35 mg/kg bw/day to obtain the RfD. The confidence level in this RfD is low since there was only 1 dose level of antimony used and no observed adverse effect level (NOAEL) was established. The subchronic oral RfD is also 4E-04 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

This constituent has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Arsenic

Symptoms of arsenic intoxication consist of fever, anorexia, hepatomegaly, melanosis, and cardiac arrythmia. Other features include upper respiratory tract symptoms, peripheral neuropathy, and gastrointestinal, cardiovascular and hematopoietic effects. Liver injury is characteristic of longer term or chronic exposure (Goyer, 1986).

The chronic oral RfD is 3E-04 mg/kg-d (EPA, 1994a). The critical effects associated with ingestion of arsenic in water and food are keratosis, hyperpigmentation and possible complications at a dose of 0.8 mg/kg-d in humans. An uncertainty factor of 3 was applied to the LOAEL of 0.8 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for the lack of reproductive toxicity data and for individual sensitivity. The confidence in the RfD is medium. The subchronic oral RfD is also 3E-04 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "A" - a human carcinogen (EPA, 1994a). Exposure to arsenic by the oral route is known to produce skin cancer, while inhalation will cause lung cancer. The slope factors for these carcinogenic effects are 1.8 $(mg/kg\text{-}d)^{-1}$ (5E-05 $(\mu g/l)^{-1}$) for ingestion and 5E+01 $(mg/kg\text{-}d)^{-1}$ (4.3E-03 $(\mu g/m^3)^{-1}$) for inhalation (EPA, 1993a, 1994a).

Barium

Symptoms of accidental poisoning from ingestion of soluble barium salts has resulted in gastroenteritis, muscular paralysis, decreased pulse rate, and ventricular fibrillation and extra-systoles (Goyer, 1986).

The chronic oral RfD for barium is 7E-02 mg/kg-d (EPA, 1994a) and is based upon drinking water studies in humans and various rodent studies. In one human study, barium (as barium chloride) was administered in the drinking water at 0 mg/L for weeks 0-2; 5 mg/L for weeks 3-6; and 10 mg/L for weeks 7-10. A NOAEL of 10 mg/L was identified in this study which corresponds to 0.21 mg/kg-d. An uncertainty factor of 3 was applied to the NOAEL to obtain this RfD. This uncertainty factor was used to account for the use of subchronic rather than chronic data. The confidence level in this RfD is medium. The subchronic oral RfD is also 7E-02 mg/kg-d (EPA, 1993a).

Occupational poisoning to barium is uncommon, but a benign pneumoconiosis (baritosis) may result from inhalation of barium sulfate dust and barium carbonate. It is not incapacitating and is usually reversible with cessation of exposure. The chronic inhalation RfD value of 1E-04 mg/kg-d (EPA, 1993a) is based on a 4 month inhalation study in rats where the critical effect was fetotoxicity. An uncertainty factor of 1,000 was applied. The subchronic inhalation RfD is 1E-03 mg/kg-d (EPA, 1993a) and was derived using an uncertainty factor of 100.

Barium has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Beryllium

The major toxicologic effects of beryllium are on the lung. It may produce an acute constituent pneumonitis, hypersensitivity or chronic granulomatous pulmonary disease (berylliosis) (Goyer, 1986).

The chronic oral RfD for beryllium is 5E-03 mg/kg-d (EPA, 1994a). This value is based upon a chronic drinking water study in rats. Beryllium was administered to rats over their lifetime at a concentration of 0 or 5 ppm (0.54 mg/kg-d) in drinking water. There were no observed adverse effects. An uncertainty factor of 100 was applied to the NOAEL to obtain the RfD. This uncertainty factor was used to account for inter- and intra-species variability. The confidence level for the RfD is low. The subchronic oral RfD is also 5E-03 mg/kg-d (EPA, 1993b). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Beryllium constituents have been shown to induce malignant lung tumors via inhalation in rats and monkeys and osteogenic sarcoma via intravenous or intramedullary injection in rabbits. The oral slope factor for beryllium is 4.3 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) and is based on tumors at multiple sites in rats exposed to beryllium in drinking water. The inhalation slope factor for beryllium is 8.4E+00 $(mg/kg\text{-}d)^{-1}$ (2.4E-03 $(\mu g/m^3)^{-1}$) (EPA, 1993a, 1994a) and is based upon lung cancer deaths among workers exposed to beryllium via inhalation.

Boron

The major toxicological effect of boron are on pulmonary and vascular systems. It may produce acute central nervous system effects, edema, hemorrhage, increase in microvascular permeability in the lung, and pulmonary edema (Goyer, 1986).

The chronic oral RfD for boron is 9E-02 mg/kg-d (EPA, 1994a). This value is based on a study in dogs. Dogs fed concentrations of 350 ppm or 1,170 ppm (8.8 mg/kg-d or 29 mg/kg-d). Severe testicular atrophy and spermatogenic arrest occurred at the 1,170 ppm dose. An uncertainty factor of 100 was applied to the NOAEL to obtain the RfD. This uncertainty factor was used to account for inter- and intra-species variability. The confidence level is medium. The subchronic RfD is also 9E-02 mg/kg-d (EPA, 1994a). The chronic and subchronic inhalation RfDs for boron are both 5.7E-03 with an uncertainty factor of 100. These RfDs were derived from an RfC of 2E-02 mg/m^3 (EPA, 1993a).

Boron has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Cadmium

Ingestion of cadmium results in nausea, vomiting and abdominal pain. Inhalation of cadmium fumes may result in an acute constituent pneumonitis and pulmonary edema (Goyer, 1986).

The chronic oral RfDs for cadmium are 5E-04 mg/kg-d (water) and 1E-03 mg/kg-d (food) (EPA, 1994a). The critical effects associated with chronic ingestion of cadmium are proteinuria and renal damage in humans. An uncertainty

factor of 10 was applied to the NOAELs (0.005 mg/kg-d for water and 0.01 mg/kg-d for food) in order to determine the RfDs. This uncertainty factor was used to account for intrahuman variability. The confidence level for the RfDs is high. In the absence of subchronic oral RfDs (EPA, 1993a), the chronic oral RfDs are used to assess subchronic exposures. Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B1" - a probable human carcinogen (limited human and sufficient animal evidence). The inhalation of cadmium has been shown to produce respiratory tract cancers in humans and various tumors in rats and mice following inhalation and injection exposures. Based on the human data, an inhalation slope factor of 6.3 $(mg/kg\text{-}d)^{-1}$ (1.8E-03 $(\mu g/m^3)^{-1}$) has been established (EPA, 1993a, 1994a). There are no positive cancer studies of orally ingested cadmium suitable for quantitation (EPA, 1994a).

Chromium III

Note: The concentrations for chromium on-site were reported as total chromium. In this HHRA, total chromium is broken down to chromium III and chromium VI assuming 86% chromium III and 14% chromium VI.

The chronic oral RfD for chromium III is 1E+00 mg/kg-d (EPA, 1994a). This RfD is based on no observed effects in rats chronically exposed to Cr_2O_3 in their diet. An uncertainty factor of 100 and a modifying factor of 10 were applied to the NOAEL of 1400 mg/kg-d in determining the RfD. The uncertainty factor was used to account for inter- and intra-species variability, while the modifying factor was used to reflect uncertainty in the NOAEL. The confidence in the RfD is low. The subchronic oral RfD is also 1E+00 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

EPA (1993a, 1994a) has not classified chromium III with regard to its potential human carcinogenicity.

Chromium VI

Note: The concentrations for chromium on-site were reported as total chromium. In this HHRA, total chromium is broken down to chromium III and chromium VI assuming 86% chromium III and 14% chromium VI.

The chronic oral RfD for chromium VI is 5E-03 mg/kg-d (EPA, 1994a) and is based upon a study in which no adverse effects were observed in rats which received 0 to 11 mg/l or 25 mg/l chromium in drinking water for 1 year. No adverse effects were seen in humans drinking well water contaminated with 1 mg/l chromium VI for 3 years. An uncertainty factor of 500 was applied to the NOAEL to obtain the RfD. This uncertainty factor was used to account for variability across and within species and the less-than-lifetime exposure duration in the key study. The confidence level in the RfD is low. The subchronic oral RfD for chromium VI is 2E-02 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for carcinogenicity of this constituent by the inhalation route is "A" - a human carcinogen (sufficient evidence in humans) (EPA, 1994a). Chromium VI produces lung tumors in humans and an inhalation slope factor of 4.1E+01 $(mg/kg\text{-}d)^{-1}$ ($(1.2E\text{-}02\ \mu g/m^3)^{-1}$) has been established based upon an epidemiologic study of chromate production workers. There is insufficient evidence for carcinogenicity of this constituent by the oral route (EPA, 1993a, 1994a).

Cobalt

Cobalt is essential as a component of Vitamin B12 which is required for the production of red blood cells. Cobalt is well absorbed orally, probably in the small intestine. Excessive cobalt intake is known to result in cardiomyopathy. One mg/kg cobalt was added to beer to enhance its foaming properties and the resultant signs and symptoms were those of congestive heart failure. Autopsy findings revealed a ten-fold increase in the cardiac levels of cobalt. Occupational exposure may result in respiratory symptoms (Goyer, 1986).

No oral or inhalation RfDs have been established by EPA (1993a, 1994a). EPA (1993a, 1994a) has also not evaluated cobalt as to its potential human carcinogenicity.

Copper

A subchronic and chronic oral RfD for copper is reported as 1.3 mg/l (3.7E-02 mg/kg-d), which is the current drinking water standard for copper (EPA, 1993a). This is based on a single dose of 5.3 mg copper which resulted in local gastrointestinal tract irritation in humans. Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Lead

The health effects of lead have been well characterized through decades of medical and scientific observation. Some of these effects include cognitive and motor defects in children, lead induced anemias, increased susceptibility to viral infections and in chronic adult lead poisoning, peripheral neuropathies. It appears that some of these effects particularly the changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (Goyer, 1986).

Based on the available data, EPA has considered it inappropriate to develop an oral RfD for inorganic lead (EPA, 1993a, 1994a). EPA (1993a, 1994a) has also not established an inhalation RfD for lead.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Lead has been shown to produce renal tumors in rats and mice following dietary and subcutaneous exposure. However, due to the many uncertainties associated with quantifying the dose-response for lead carcinogenicity, EPA (1993a, 1994b) has not established slope factors for lead.

Manganese

Exposure to manganese results in two types of toxicities. The first, the result of acute inhalation exposure, results in manganese pneumonitis. The second, and more serious of the two, results from chronic exposure to manganese either by the oral or inhalation routes. Chronic manganese poisoning results in a psychiatric disorder characterized by psychological and motor difficulties (Goyer, 1986).

EPA (1994a) has established two chronic oral RfDs for manganese: 5E-03 mg/kg-d for water ingestion and 1.4E-01 mg/kg-d for food ingestion. The chronic water RfD is based on an epidemiological study of people exposed to manganese in their drinking water. Central nervous system effects occurred at a LOAEL of 6E-02 mg/kg-d. An uncertainty factor of 1 was applied to the reported NOAEL of 5E-03 mg/kg-d to obtain the RfD. The chronic food RfD is based on three studies of dietary exposure to manganese in humans. No adverse effects were reported for dietary exposures up to 1.6E-01 mg/kg-d. An uncertainty factor of 1 was applied to the selected NOAEL of 1.4E-01 mg/kg-d in deriving the chronic food RfD. A confidence level is not reported for these RfDs. The chronic RfD for inhalation is 1.1E-04 mg/kg-d (4E-04 mg/m^3) (EPA, 1993a) and is based upon a study of occupational exposure to inorganic manganese. An uncertainty factor of 300 and a modifying factor of 3 were applied to the LOAEL of 3.4E-01 mg/m^3 to obtain the RfD. These factors were used to account for individual sensitivity, the use of a LOAEL rather than a NOAEL, and the use of less-than-chronic exposure data. The confidence level in these RfDs is medium.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Mercury

Exposure to mercury vapor may produce an acute, corrosive bronchitis and interstitial pneumonitis resulting in either death or symptoms of central nervous system effects such as tremor or increased excitability. Ingestion of mercuric salts results in corrosive ulceration, bleeding and necrosis of the gastrointestinal tract usually accompanied by shock and circulatory collapse. Renal failure occurs within 24 hours. Chronic mercury poisoning mainly affects the central nervous system. Characteristic symptoms include increased excitability, tremors, gingivitis, and increased salivation. There have been some instances of proteinuria and renal damage in persons chronically exposed to mercury vapors (Goyer, 1986).

The chronic oral RfD for mercury is 3E-04 mg/kg-d (EPA, 1993a), in order to prevent the critical effect of renal damage. An uncertainty factor of 1,000 was applied in order to determine the RfD. The subchronic oral RfD for mercury is also 3E-04 mg/kg-d (EPA, 1993a).

The chronic RfD value for inhalation for mercury is 3E-04 mg/m^3 (8.6E-05 mg/kg-d) (EPA, 1993a) and is based upon several occupational studies. Neurotoxicity was the critical effect following inhalation exposure. An uncertainty factor of 30 was applied to obtain the RfD. The subchronic inhalation RfD is also 8.6E-05 mg/kg-d (EPA, 1993a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Nickel

Nickel is a common allergen which results in allergic contact dermatitis (Goyer, 1986).

The chronic oral RfD for nickel (soluble salts) is 2E-02 mg/kg-d (EPA, 1994a) and is based on a chronic feeding study in rats. At the LOAEL of 50 mg/kg-d, decreased body and organ weights were observed. An uncertainty factor of 300 was applied to the reported NOAEL of 5 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for variability across and within species and observed inadequacies in the available reproductive studies. The confidence level in the RfD is medium. The subchronic oral RfD is also 2E-02 mg/kg-d (EPA, 1993b). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for carcinogenicity of nickel (refinery dust) by the inhalation route is "A" - a human carcinogen. Nickel (refinery dust) produces lung and nasal tumors and an inhalation slope factor of 8.4E-01 $(mg/kg\text{-}d)^{-1}$ (2.4E-04 $(\mu g/m^3)^{-1}$) has been established (EPA, 1994a). This value is based on lung tumors among sulfide nickel matte refinery workers in several countries. There is insufficient evidence for carcinogenicity of nickel (refinery dust) by the oral route (EPA, 1993a, 1994a).

Selenium

The availability as well as toxic potential of selenium is related to its constituent form. Selenates are readily absorbed from the gastrointestinal tract whereas elemental selenium is probably not absorbed. Acute selenium poisoning produces central nervous system effects including nervousness, drowsiness and sometimes convulsions. Eye and nasal irritation may occur from exposure to vapors. Signs of chronic selenium intoxication in humans may include discolored or decaying teeth, skin eruptions, gastrointestinal distress, lassitude and partial loss of hair and nails (Goyer, 1986).

The chronic oral RfD for selenium is 5E-03 mg/kg-d (EPA, 1994a). The critical effects associated with selenium exposure are constituent selenosis, including CNS abnormalities. An uncertainty factor of 3 was applied to the NOAEL in sensitive individuals to obtain the RfD. The confidence level in this RfD is high. A subchronic RfD of 5E-03 mg/kg-d has been established (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993a, 1994a).

Silver

The major effect of excessive absorption of silver is local or generalized impregnation of the tissues where it remains as silver sulfide, which forms an insoluble complex in elastic fibers resulting in argyria (Goyer, 1986).

The chronic oral RfD for silver is 5E-03 mg/kg-d (EPA, 1994a) and is based upon 2 to 9 year therapeutic i.v. treatments with silver in humans. Similar to other silver studies, argyria was the critical effect. In the key study, patients

received a total of 1 to 4.6 g of silver via i.v. injection over 2 to 9 years. An uncertainty factor of 3 was applied to the LOAEL of 1 g silver (0.014 mg/kg-d) to derive the RfD. This uncertainty factor was used to account individual sensitivity. The confidence level in the RfD is low. The subchronic oral RfD is also 5E-03 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification of the human carcinogenic potential of silver is "D" - not classified as to human carcinogenicity (EPA, 1993a, 1994a).

Thallium

Thallium is one of the more toxic metals and can cause neural, hepatic and renal injury. It may also cause deafness and loss of vision. In some cases, deaths in humans have been reported as a result of long-term systemic thallium intake. These cases usually are caused by the contamination of food or the use of thallium as a depilatory.

The chronic oral RfD for thallium carbonate is 8E-05 mg/kg-d (EPA, 1994a) and is based on a gavage study in rats. Administration of 0.20 mg thallium/kg/day for 90 days to rats produced increased SGOT levels and serum LDH levels and alopecia. An uncertainty factor of 3,000 was used to obtain this RfD. A subchronic oral RfD of 8E-04 mg/kg-d (EPA, 1993a) was established using an uncertainty factor of 300. Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" (EPA, 1994a).

Vanadium

Vanadium is an ubiquitous element. Industrial exposure to vanadium may lead to bronchitis and bronchopneumonia. Vanadium overexposure may also cause skin and eye irritation, gastrointestinal distress, nausea, vomiting, abdominal pain, cardiac palpitation, tremor, nervous depression and kidney damage (Goyer, 1986). Ingestion of vanadium constituents may produce gastrointestinal disturbances, slight abnormalities of clinical chemistry related to renal function and nervous system effects.

The chronic oral RfD for vanadium is 7E-03 mg/kg-d (EPA, 1993a) and is based on a chronic drinking water study in rats. No critical effects were observed in rats following lifetime administration of 5 ppm vanadium in drinking water (converted to 7E-01 mg/kg-d). An uncertainty factor of 100 was applied to the NOAEL to obtain the RfD. The subchronic oral RfD is also 7E-03 mg/kg-d (EPA, 1993a). Short-term inhalation exposure to high levels of vanadium has been shown to produce toxic effects in the lung, kidney, liver, adrenals and bone marrow in experimental animals. Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

EPA (1993a, 1994a) has not evaluated vanadium with regard to its potential carcinogenicity in humans.

Zinc

Zinc is ubiquitous in the environment so that it is present in most food stuffs, water and air. About 20 to 30 percent of ingested zinc is absorbed. Acute toxicity from the ingestion of excessive zinc is uncommon (Goyer, 1986).

The chronic oral RfD for zinc is 3E-01 mg/kg-d (EPA, 1994a). This value is based on a therapeutic dosage of 59.72 mg/kg-d which resulted in a 47% decrease in erythrocyte superoxide dismutase (ESOD) concentration in adult females after 10 weeks of zinc exposure. An uncertainty factor of 3 was applied to obtain the RfD. The confidence in this RfD is medium. The subchronic oral RfD is also 3E-01 mg/kg-d (EPA, 1993a). Inhalation RfDs are not available (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993a, 1994a).

B.2 Volatiles

Acetone

The chronic oral RfD for acetone is 1E-01 mg/kg-d (EPA, 1994a) and is based on a subchronic oral study in rats. Acetone was administered by gavage for 90 days to groups of albino rats at doses of 0, 100, 500 or 2,500 mg/kg-d. The LOAEL was 500 mg/kg-d and the critical effects were increased liver and kidney weights and nephrotoxicity. An uncertainty factor of 1,000 was applied to the NOEL of 100 mg/kg-d to obtain the RfD. The uncertainty factor was used to account for inter- and intra-species variability and the use of subchronic data. The confidence level in this RfD is low. The subchronic oral RfD for acetone is 1E+00 (EPA, 1993a) and is based on the same gavage study. Inhalation RfDs for acetone are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Benzene

Oral and inhalation RfDs for benzene have not been established (EPA, 1994a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "A" - human carcinogen. Several studies have shown benzene to increase the incidence of nonlymphocytic leukemia in humans from occupational exposure. An oral slope factor of 2.9E-02 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) and an inhalation unit risk factor of 8.3E-06 $(ug/m^3)^{-1}$ (2.9E-02 $(mg/kg\text{-}d)^{-1}$) have been established (EPA, 1993a, 1994a).

Butanone, 2-

The chronic oral RfD for 2-butanone is 6E-01 mg/kg-d (EPA, 1994a) and is based on a multigeneration, developmental feeding study in rats. The LOAEL was 3,122 mg/kg-d and the critical effect observed was decreased fetal birth weight. The NOAEL was 1,771 mg/kg-d. An uncertainty factor of 3,000 was applied to the NOAEL to obtain the RfD. The confidence level in this RfD is low. The subchronic oral RfD for 2-butanone is 2E-01 mg/kg-d (EPA, 1993a), and is based on the same feeding study in rats, with an applied safety factor of 1,000. The chronic inhalation RfD for 2-butanone is 2.9E-01 mg/kg-d (1E+00 mg/m^3; EPA, 1994a) and is based on a developmental, inhalation study in mice. The LOAEL was 8,906 mg/m^3 and the critical effect was decreased fetal birth weight. The NOAEL was 2,978 mg/m^3. An uncertainty factor of 1,000 and a modifying factor of 3 were applied to the NOAEL to obtain the RfD. The confidence level in this RfD is low. The subchronic inhalation RfD for 2-butanone is also 2.9E-01 mg/kg-d (EPA, 1993a) based on the study and UF cited previously.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Carbon Disulfide

Adverse effects of human exposure to carbon disulfide resulting from prolonged exposure to high levels of carbon disulfide include organic brain damage, peripheral nervous system decrements, neurobehavioral dysfunction and ocular and auditory effects. Adverse effects on the cardiovascular system have also been reported (Goyer, 1986).

The chronic oral RfD for carbon disulfide is 1.1E-01 mg/kg-d (EPA, 1994a). This value is based on route-to-route extrapolation of data from a rabbit inhalation study (EPA, 1994a). Rabbits were exposed to 20 ppm or 40 ppm of carbon disulfide for 34 weeks prior to breeding and during the entire length of the pregnancy period. The NOEL for this study was 20 ppm (converted to 11 mg/kg-d). An uncertainty factor of 100 was applied to the NOEL to obtain the RfD. The confidence level in this RfD is medium.

The chronic inhalation RfD for carbon disulfide is 1E-02 mg/m^3 (2.9E-03 mg/kg-d) and is based upon an inhalation study in rats (EPA, 1993a). Rats were exposed to carbon disulfide at different concentrations for 8 hours/day

during gestation. The NOAEL was 10 mg/m^3 and the critical effect was fetal toxicity. An uncertainty factor of 1,000 was applied to obtain the RfD.

Carbon disulfide has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Chlorobenzene

The chronic oral RfD for chlorobenzene is 2E-02 mg/kg-d (EPA, 1994a) and is based on a 13 week dog study. Beagle dogs received chlorobenzene orally by capsule at doses of 27.25, 54.5, or 272.5 mg/kg-d for 5 days/week for 13 weeks. The LOAEL was 54.5 mg/kg-d and the critical effects observed were histopathological changes in the liver as well as changes in the blood chemistry. An uncertainty factor of 1,000 was applied to the NOAEL of 19 mg/kg-d (adjusted from 27.25 mg/kg-d to take into account X exposure) to obtain the RfD. The confidence level in this RfD is medium. The subchronic oral RfD has not been established (EPA, 1993a), and for the purpose of this HHRA the chronic oral RfD is used.

The chronic inhalation RfD for chlorobenzene is 5E-03 mg/kg-d (EPA, 1993a) and is based upon a chronic study in rats. Rats were exposed to chlorobenzene at doses of 75 ppm for 7 hours/day, 5 days/week for 120 days. An uncertainty factor of 10,000 was applied to obtain the RfD. The critical effects observed were liver and kidney effects. A subchronic inhalation RfD is not available (EPA, 1993a), and for the purpose of this HHRA the chronic value is used.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Ethylbenzene

The chronic oral RfD for ethylbenzene is 1E-01 mg/kg-d (EPA, 1994a) and is based on a oral subchronic rat bioassay. Rats received oral doses of 13.6, 136, 408, or 680 mg/kg-d in olive oil for 26 weeks. The LOAEL was 408 mg/kg-d and the critical effects observed were liver and kidney toxicity. An uncertainty factor of 1,000 was applied to the NOAEL of 97.1 mg/kg-d (adjusted from 136 mg/kg-d to take into account 5/7 day exposure) to obtain the RfD. The confidence level in this RfD is low. There were no adverse effects seen in human volunteers exposed to 100 ppm (435 mg/cu.m) for eight hours. Since a subchronic oral RfD is not available (EPA, 1993a), the chronic value is used in this HHRA.

The chronic inhalation RfD has been established and verified as 2.9E-01 mg/kg-d (1E+00 mg/m^3) (EPA, 1994a) and is based upon inhalation studies in rats and rabbits. Rats were exposed to ethylbenzene on gestation days 1-19 and rabbits were exposed on gestation days 1-24. Exposures were for 6-7 hours/day. The NOAEL was 434 mg/m^3 and the critical effect observed was developmental toxicity. An uncertainty factor of 300 was applied to the NOAEL. The confidence level in this RfD is low. Since a subchronic inhalation RfD is not available (EPA, 1993a), the chronic inhalation RfD is used in this HHRA.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Methyl-2-Pentanone, 4-

The chronic oral RfD for this constituent is 5E-02 mg/kg-d (EPA, 1993a) based upon liver and kidney toxicity in rats during a chronic gavage study. Rats were given 4-methyl-2-pentanone by gavage for 13 weeks. No effects were observed at a dose of 50 mg/kg-d. An uncertainty factor of 1,000 was applied to the LOAEL to obtain this RfD.

The chronic inhalation RfD for this constituent is 2E-02 mg/kg-d (8E-02 mg/m^3; EPA, 1993a) and is based upon increased liver weight and kidney toxicity in rats during a chronic inhalation study. Rats were exposed to 4-methyl-2-pentanone for 90 days. A NOAEL of 50 ppm was observed. An uncertainty factor of 1,000 was applied to the NOAEL to obtain this RfD.

This constituent has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Methylene Chloride

The chronic oral RfD for methylene chloride is 6E-02 mg/kg-d (EPA, 1994a) and is based on a drinking water bioassay in rats. Rats were given methylene chloride at doses of 5, 50, 125 or 250 mg/kg-d in drinking water for 2 years. The LOAEL was 52.58 and 58.32 mg/kg-d for males and females, respectively and the critical effect was liver toxicity. The NOAELs were 5.85 and 6.47 mg/kg-d for males and females, respectively and an uncertainty factor of 100 was applied to these NOAELs to obtain the RfD. This uncertainty factor was used to account for inter- and intra-species variability. The confidence level in the RfD is medium. The subchronic oral RfD is also 6E-02 mg/kg-d (EPA, 1993a).

The chronic inhalation RfD for methylene chloride is 8.6E-01 mg/kg-d (3E+00 mg/m^3) (EPA, 1993a). This value is based upon a chronic inhalation study in rats. Rats were exposed intermittently to methylene chloride in air for 2 years. The NOAEL was 694.8 mg/m^3 and an uncertainty factor of 100 was applied to obtain the RfD. The subchronic inhalation RfD is also 8.6E-01 mg/kg-d (EPA, 1993a).

The EPA weight-of-evidence classification for human carcinogenicity is "B2" - probable human carcinogen (sufficient evidence in animals, inadequate or lack of evidence in humans) (EPA, 1994a). Methylene chloride has been shown to induce increased incidence of hepatocellular neoplasms and alveolar/bronchiolar neoplasms in male and female mice, and increased incidence of benign mammary tumors in both sexes of rats, salivary gland sarcomas in male rats and leukemia in female rats. An oral slope factor of 7.5E-03 $(mg/kg-d)^{-1}$ (EPA, 1994a) calculated as the arithmetic mean of slope factors derived from an inhalation mouse study and an oral/drinking water study in mice has been established. An inhalation slope factor of 1.6E-03 $(mg/kg-d)^{-1}$ (4.7E-07 $(\mu g/m^3)^{-1}$) (EPA, 1994a) has been established based upon the induction of adenomas and carcinomas (liver and lung) in mice following inhalation exposure.

Tetrachloroethene

The chronic oral RfD for tetrachloroethene is 1E-02 mg/kg-d (EPA, 1994a) and is based upon a gavage study in mice. Swiss-Cox mice were exposed to tetrachloroethene by gavage at doses of 0, 20, 100, 200, 500, 1500, and 2000 mg/kg-d, 5 days/week for 6 weeks. The LOAEL was 100 mg/kg-d (converted to 71 mg/kg-d) and the critical effects observed were increased liver triglycerides and increased liver weight/body weight ratios. An uncertainty factor of 1,000 was applied to the NOAEL of 20 mg/kg-d (converted to 14 mg/kg-d) to obtain the oral RfD. The confidence level in this RfD is medium. A subchronic oral RfD of 1E-01 mg/kg-d has been established (EPA, 1993a). Inhalation RfDs for tetrachloroethene are not available at this time (EPA, 1993a, 1994a).

The oral slope factor is 5.2E-02 $(mg/kg-d)^{-1}$ (EPA, 1992d) on the basis of a mouse gavage study. Liver tumors were induced following tetrachloroethene administration. The inhalation slope factor has been established at 2E-03 $(mg/kg-d)^{-1}$ (EPA, 1992d) and is based upon an inhalation study in rats and mice. Leukemia and liver lesions were observed following tetrachloroethene exposure. The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2/C" - probable human carcinogen (EPA, 1992d).

Toluene

The chronic oral RfD for toluene is 2E-01 mg/kg-d (EPA, 1994a) and is based on a subchronic oral gavage study in rats. F344 rats received oral doses of 0, 312, 625, 1250, 2500, or 5000 mg/kg-d for 5 days/week for 13 weeks. The LOAEL was 625 mg/kg-d and the critical effects observed were changes in liver and kidney weights. An uncertainty factor of 1,000 was applied to the NOAEL of 223 mg/kg-d (adjusted from 312 mg/kg-d to take into account 5/7 day exposure) to obtain the RfD. The confidence level in this RfD is medium. There were no adverse effects seen in human volunteers exposed to 100 ppm for twenty minutes. When exposed to 200 ppm for twenty minutes they exhibited incoordination, exhilaration, and prolonged reaction times. The subchronic oral RfD is 2E+00 mg/kg-d (EPA, 1993a).

The chronic inhalation RfD for toluene is 1.1E-01 mg/kg-d (4E-01 mg/m^3) (EPA, 1994a) and is based upon human exposure data. This value is based on the occupational exposure of 30 female workers. Exposed workers breathed toluene air levels of 88 ppm (332 mg/m^3) as a TWA and control workers 13 ppm (49 mg/m^3) (TWA). A battery of eight

neurobehavioral tests were administered to the exposed and control workers. All tests demonstrated that exposed workers performed poorly compared with the control cohort, with statistical significance seen in 6 of the 8 tests. An uncertainty factor of 300 was applied to the LOAEL of 119 mg/m^3 to obtain this RfD. The confidence level in this RfD is medium. Since a subchronic inhalation RfD is not available at this time (EPA, 1993a), the chronic value is used for the purpose of this HHRA.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Trichloroethane, 1,1,1-

Oral and inhalation RfDs are not available for this constituent (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Trichloroethene

Oral and inhalation RfDs have not been established for this constituent (EPA, 1993a, 1994a).

The oral slope factor value of 1.1E-02 $(mg/kg-d)^{-1}$, based upon a mouse gavage study has been established (EPA, 1992d). The inhalation slope factor of 6E-03 $(mg/kg-d)^{-1}$ (EPA, 1992d) has been established. It is based upon two inhalation studies in mice. Lung tumors were induced. The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2/C" - probable human carcinogen (EPA, 1992d).

Xylenes

The chronic oral RfD for xylenes is 2E+00 mg/kg-d (EPA, 1994a) and is based on a chronic oral gavage study in rats and mice. Rats and mice were given oral gavage doses of 0, 250 or 500 mg/kg-d (rats) and 0, 500 or 1,000 mg/kg-d (mice) for 5 days/week for 105 weeks. There was a dose-related increase in the mortality levels seen in male rats, as well as hyperactivity and decreased body weights. An uncertainty factor of 100 was applied to the NOAEL of 179 mg/kg-d

(adjusted from 250 mg/kg-d to take into account 5/7 day exposure) to obtain the RfD. The confidence level in this RfD is medium. Since a subchronic oral RfD is not available for xylenes (EPA, 1993a), the chronic oral RfD is used. Inhalation RfDs for xylenes are not available (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

B.3 Semi-Volatiles

Acenaphthene

The chronic oral RfD for acenaphthene is 6E-02 mg/kg-d (EPA, 1994a) and is based on a subchronic gavage study in mice. Mice received 0, 175, 350, or 700 mg/kg-d acenaphthene by oral gavage for 90 days. The LOAEL was 350 mg/kg-d and the critical effects observed were liver weight changes accompanied by microscopic alterations. No treatment related effects on survival, clinical signs or body weight changes were observed. An uncertainty factor of 3000 was applied to the NOAEL of 175 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for inter- and intra-species variability, the use of subchronic data, and the lack of additional adequate data. The confidence level in the RfD is low. The subchronic oral RfD for acenaphthene is 6E-01 mg/kg-d (EPA, 1993a). Inhalation RfDs are not available at this time (EPA, 1993a, 1994a).

This constituent has not yet been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Acenaphthylene

Oral and inhalation RfDs are not available for this constituent (EPA, 1993a, 1994a). In the absence of oral RfDs for this constituent, the oral RfDs for naphthalene are cross-assigned.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Anthracene

The chronic oral RfD for anthracene is 3E-01 mg/kg-d (EPA, 1994a) and is based on a subchronic gavage study in mice. Mice received 0, 250, 500, or 1,000 mg/kg-d anthracene by oral gavage for 90 days. No treatment related effects on survival, clinical signs or body weight changes were observed. An uncertainty factor of 3000 was applied to the NOAEL of 1,000 mg/kg-d to obtain the RfD. The confidence level in this RfD is low. A subchronic oral RfD of 3E+00 mg/kg-d has been established (EPA, 1993a). Inhalation RfDs are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Benzoic Acid

The chronic oral RfD for benzoic acid is 4E+00 mg/kg-d (EPA, 1994a) and is based on FDA data regarding the amounts of benzoic acid and sodium benzoate produced as a food preservative. The FDA estimated a daily per capita intake of 0.9-34 mg for benzoic acid and 34-328 mg for sodium benzoate. At these levels, there are no reports of toxic effects in humans. These constituents have Generally Recognized as Safe (GRAS) status by FDA. Therefore, the upper ranges can be considered NOAELs for benzoic acid and sodium benzoate. No uncertainty factors are applied and based on conversion factors, the chronic oral RfD for benzoic acid has been established at 312 mg/day for a 70 kg human or 4 mg/kg-d. The confidence in the RfD is medium. The subchronic oral RfD for benzoic acid is also 4E+00 mg/kg-d (USEPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the human carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Benzo(a)anthracene

EPA (1993a, 1994a) has not established oral or inhalation RfDs for benzo(a)anthracene.

The EPA (1994a) weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence). Although oral and inhalation oral slope

factors for benzo(a)anthracene have not been established (EPA, 1993a, 1994a), this constituent has been shown to produce liver, lung and skin cancer in animals. Per EPA Region I guidance, the oral slope factor for benzo(a)pyrene (7.3 $(mg/kg\text{-}d)^{-1}$) is assigned to this B2 carcinogen. For comparison purposes, a second approach is also used in which the constituent-specific toxic equivalency factor (TEF) for benzo(a)anthracene (0.145) developed by ICF-Clement Associates (1987) is applied to the slope factor for benzo(a)pyrene.

Benzo(a)pyrene

EPA (1993a, 1994a) has not established oral or inhalation RfDs for benzo(a)pyrene.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Benzo(a)pyrene has been shown to produce lung and stomach cancer in animals. EPA's (1994a) oral slope factor of 7.3 $(mg/kg\text{-}d)^{-1}$ for benzo(a)pyrene is based on forestomach tumors observed in mice following up to 196 days of dietary exposure to benzo(a)pyrene. An inhalation slope factor for benzo(a)pyrene has not been established (EPA, 1993a, 1994a).

Benzo(b)fluoranthene

EPA (1993a, 1994a) has not established oral or inhalation RfDs for benzo(b)fluoranthene.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Although oral and inhalation slope factors for benzo(b)fluoranthene have not been established (EPA, 1993a, 1994a), this constituent has been shown to produce lung and thorax carcinomas, lung adenomas and skin tumors in animals. Per EPA Region I guidance, the oral slope factor for benzo(a)pyrene (7.3 $(mg/kg\text{-}d)^{-1}$) is assigned to this B2 carcinogen. For comparison purposes, a second approach is also used in which the constituent-specific toxic equivalency factor (TEF) for benzo(b)fluoranthene (0.140) developed by ICF-Clement Associates (1987) is applied to the slope factor for benzo(a)pyrene.

Benzo(e)pyrene

Oral and inhalation RfDs for benzo(e)pyrene have not been established (EPA, 1993a, 1994a).

Benzo(e)pyrene has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Benzo(g,h,i)perylene

EPA (1993a, 1994a) has not established oral or inhalation RfDs for benzo(g,h,i)perylene. In the absence of oral RfDs for this constituent, the oral RfDs for naphthalene are cross-assigned.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Benzo(k)fluoranthene

EPA (1993a, 1994a) has not established oral or inhalation RfDs for benzo(k)fluoranthene. In the absence of oral RfDs for this constituent, the oral RfDs for naphthalene are cross-assigned.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Although oral and inhalation slope factors for benzo(k)fluoranthene have not been established (EPA, 1993a, 1994a), this constituent has been shown to produce lung and thorax carcinomas, lung adenomas and skin tumors in animals. Per EPA Region I guidance, the oral slope factor for benzo(a)pyrene (7.3 $(mg/kg\text{-}d)^{-1}$) is assigned to this B2 carcinogen. For selected sites, a second approach is also used in which the constituent-specific toxic equivalency factor (TEF) for benzo(k)fluoranthene (0.066) developed by ICF-Clement Associates (1987) is applied to the slope factor for benzo(a)pyrene.

Biphenyl

The chronic RfD for biphenyl is 5E-02 (mg/kg-d) and is based on an oral study in rats (EPA, 1994a). The confidence level is medicine. This value was applied to subchronic effects since no information was available in HEAST (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

Biphenyl has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Bis(2-ethylhexyl)phthalate

The chronic oral RfD for Bis(2-ethylhexyl)phthalate (BEHP) is 2E-02 mg/kg-d (EPA, 1994a) and is based on a subchronic feeding study in guinea pigs. Guinea pigs received 19 or 64 mg/kg-d BEHP in their food for 1 year. There were no treatment related toxic effects, however both dose groups had increased liver weights. An uncertainty factor of 1,000 was applied to the LOAEL of 19 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for inter- and intra-species variability, and a less-than-lifetime exposure. The confidence level in the RfD is medium. Since a subchronic oral RfD for BEHP is not available (EPA, 1993a), the chronic oral RfD is used in this HHRA. Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence). The oral slope factor for BEHP is 1.4E-02 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) and is based on BEHPs ability to produce liver tumors in animals. A quantitative estimate of carcinogenic risk from inhalation exposure is not available (EPA, 1993a, 1994a).

Butylbenzylphthalate

The chronic oral RfD for butyl benzyl phthalate is 2E-01 mg/kg-d (EPA, 1994a) and is based on a subchronic feeding study in rats. Rats received 0, 17, 51, 159, 470, 1417 mg/kg-d butyl benzyl phthalate in their diet for 26 weeks. The LOAEL was 470 mg/kg-d and the critical effects observed were a decrease in body weight, decreased testes' size, decreased organ weights and hematological effects. An uncertainty factor of 1,000 was applied to the NOAEL of 159 mg/kg-d to obtain the RfD. The confidence level in this RfD is medium. The subchronic oral RfD is 2E+00, using an uncertainty factor of 100 (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "C" - a possible human carcinogen (EPA, 1994a) based upon an increase in mononuclear cell leukemia in female rats fed butyl benzyl phthalate at doses of 0.6000 or 12,000 ppm. A quantitative estimate of carcinogenic risk from oral or inhalation exposures is not available (EPA, 1993a, 1994a).

Carbazole, 9H

EPA (1993a, 1994a) has not established oral or inhalation RfDs for this constituent.

The EPA weight-of-evidence classification for this constituent was not found (EPA, 1993a, 1994a).

Chrysene

The available data is inadequate for quantitative non-cancer risk assessment (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Although oral and inhalation slope factors for chrysene have not been established (EPA, 1993a, 1994a), this constituent has been shown to produce carcinomas and malignant lymphomas in mice after intraperitoneal exposure, and skin carcinomas in mice after dermal exposure. Per EPA Region I guidance, the oral slope factor for benzo(a)pyrene (7.3 $(mg/kg\text{-}d)^{-1}$) is assigned to this B2 carcinogen. For comparison purposes, a second approach is also used in which the constituent-specific toxic equivalency

factor (TEF) for chrysene (0.0044) developed by ICF-Clement Associates (1987) is applied to the slope factor for benzo(a)pyrene.

Chrysenes, Mono-Substituted Methyl-, Di-Substituted Methyl-, Tri-Substituted Methyl-, Tetra-Substituted Methyl-

Refer to chrysene.

Dibenzofuran

Data is inadequate for a quantitative risk assessment (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Dibenzothiophene

Data are inadequate for quantitative risk assessment and, therefore, no RfDs were found in IRIS or HEAST (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent was not found (EPA, 1994a).

Dibenzothiophenes, Mono-Substituted Methyl-, Di-Substituted Methyl-, Tri-Substituted Methyl-, Tetra-Substituted Methyl-

Refer to dibenzothiophene.

Dibenzo(a,h)anthracene

EPA (1993a, 1994a) has not established oral or inhalation RfDs for dibenzo(a,h)anthracene.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Although oral and inhalation

slope factors for dibenzo(a,h)anthracene have not been established (EPA, 1993a, 1994a), this constituent has been shown to produce lung and mammary tumors after oral administration, skin carcinomas after dermal exposure, and fibrosarcomas after subcutaneous injection in animals. Per EPA Region I guidance, the oral slope factor for benzo(a)pyrene (7.3 $(mg/kg\text{-}d)^{-1}$) are assigned to this B2 carcinogen. For comparison purposes, a second approach is also used in which the constituent-specific toxic equivalency factor (TEF) for dibenzo(a,h)anthracene (1.11) developed by ICF-Clement Associates (1987) is applied to the slope factor for benzo(a)pyrene.

Dichlorobenzene, 1,4-

No oral RfD was found in either IRIS or HEAST (EPA, 1993a, 1994a).

The chronic inhalation RfD for 1,4-dichlorobenzene has been established as 2.2E-01 mg/kg-d based on an inhalation unit risk of 8E-01 mg/m^3 (EPA, 1993a). The value is based upon an inhalation study in rats. Rats were exposed to 1,4-dichlorobenzene at a concentration of 75 ppm (454.6 mg/m^3) for 5 hours/day, 5 days/week for 76 weeks. The critical effects observed were liver and kidney changes. An uncertainty factor of 100 was applied to obtain the RfD. The chronic inhalation RfC was adopted as the subchronic RfC (EPA, 1993a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "C" - a possible human carcinogen (limited animal evidence, inadequate/no human evidence). The oral slope factor for 1,4-dichlorobenzene is 2.4E-02 $(mg/kg\text{-}d)^{-1}$ (EPA, 1993a). In a 103 week oral gavage study in mice 1,4-dichlorobenzene produced liver tumors. An inhalation slope factor for 1,4-dichlorobenzene is not available (EPA, 1993a, 1994a).

Dichlorophenol, 2,4-

The chronic oral RfD for 2,4-dichlorophenol is 3E-03 mg/kg-d (EPA, 1994a) and is based upon a subchronic to chronic drinking water study in rats. Female rats were exposed to 3, 30 or 300 ppm 2,4-dichlorophenol in drinking water from weaning age through breeding at 90 days, parturition and weaning of pups. The LOAEL was 30 ppm (converted to 3 mg/kg-d) and the critical effects were decreased delayed hypersensitivity response. The NOEL was 3 ppm (converted to 0.3 mg/kg-d). An UF of 100 was applied to the NOEL to obtain the RfD. The confidence level in this RfD is low. Inhalation RfDs for 2,4-dichlorophenol are not available at this time (EPA, 1993a, 1994a).

This constituent has not been evaluated by the EPA for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Diethyl phthalate

The chronic oral RfD for diethyl phthalate is 8E-01 mg/kg-d (EPA, 1994a) and is based on a subchronic feeding study in rats. Rats received 0, 150, 770, and 3160 mg/kg-d diethyl phthalate in their diet for 16 weeks. The LOAEL was 3160 mg/kg-d and the critical effects observed were a decrease in body weight, decreased food consumption and altered organ weights. No changes in behavior or other clinical signs of toxicity were observed. An uncertainty factor of 1,000 was applied to the NOAEL of 770 mg/kg-d to obtain the RfD. The confidence level in this RfD is low. A subchronic RfD of 8E+00 mg/kg-d (EPA, 1993a) has been adopted based on an uncertainty factor of 100. Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Di-n-butyl phthalate

The chronic oral RfD for di-n-butyl phthalate is 1E-01 mg/kg-d (EPA, 1993a) and is based on a subchronic feeding study in rats. Rats received 0, 0.01, 0.05, 0.25 and 1.25 percent di-n-butyl phthalate in their diet for 1 year. The LOAEL was 600 mg/kg-d (1.25%) and the critical effect observed was an increase in mortality. No changes in behavior or other clinical signs of toxicity were observed. An uncertainty factor of 1,000 was applied to the NOAEL of 125 mg/kg-d (0.25%) to obtain the RfD. The confidence level in this RfD is low. A subchronic oral RfD of 1E+00 mg/kg-d (EPA, 1993a) is based on an uncertainty factor of 100. Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Fluoranthene

The chronic oral RfD for fluoranthene is 4E-02 mg/kg-d (EPA, 1994a) and is based on a subchronic gavage study in mice. Mice received 0, 125, 250, or 500 mg/kg-d fluoranthene by oral gavage for 13 weeks. The LOAEL was 250 mg/kg-d and the critical effects seen were neuropathy, increased salivation, kidney toxicity, increased liver enzymes and hematological/clinical changes. An uncertainty factor of 3000 was applied to the NOAEL of 125 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for inter- and intra-species variability, the use of subchronic rather than chronic data, and for the lack of additional supporting data. The confidence level in the RfD is low. The subchronic oral RfD for fluoranthene is 4E-01 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Fluoranthene/Pyrenes, Mono-Substituted Methyl-

Refer to fluoranthene and pyrene.

Fluorene

The chronic oral RfD for fluorene is 4E-02 mg/kg-d (EPA, 1994a) and is based on a subchronic gavage study in mice. Mice received 0, 125, 250, or 500 mg/kg-d fluorene by oral gavage for 13 weeks. The LOAEL was 250 mg/kg-d and the critical effects seen were neuropathy, increased salivation, increased liver enzymes and hematological effects. An uncertainty factor of 3000 was applied to the NOAEL of 125 mg/kg-d to obtain the RfD. The confidence level in this RfD is low. The subchronic oral RfD of 4E-01 mg/kg-d has been established (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Fluorenes, Mono-Substituted Methyl-, Di-Substituted Methyl-, Tri-Substituted Methyl-

Refer to fluorene.

Indeno(1,2,3-cd)pyrene

EPA (1993a, 1994a) has not established oral or inhalation RfDs for indeno(1,2,3-cd)pyrene.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Although oral and inhalation slope factors for indeno(1,2,3-cd)pyrene have not been established (EPA, 1993a, 1994a), this constituent has been shown to produce lung and thorax tumors following lung implantations, and skin tumors following dermal exposure in animals. Per EPA Region I guidance (EPA, 1994a), the oral slope factor for benzo(a)pyrene (7.3 $(mg/kg\text{-}d)^{-1}$) is assigned to this B2 carcinogen. For comparison purposes, a second approach is used in which the toxic equivalency factor (TEF) for indeno(1,2,3-cd)pyrene (0.232) developed by ICF-Clement Associates (1987) is applied to the slope factor for benzo(a)pyrene.

Methylnaphthalene, 2-

No RfDs were found for 2-methylnaphthalene (EPA, 1993a, 1994a). In the absence of RfDs for this constituent, the values for naphthalene are used in the HHRA.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is not available (EPA, 1993a, 1994a).

Methylphenol, 4-

The chronic oral RfD for 4-methylphenol is 5E-03 mg/kg-d (EPA, 1994a) and is based on a gavage study done in pregnant rabbits. The rabbits were given 5 mg/kg-d 4-methylphenol on gestation days 6-18. The critical effect was maternal death. An uncertainty factor of 1,000 was applied to obtain the RfD. The subchronic oral RfD is 5E-02 mg/kg-d (EPA, 1993a) and is based on an uncertainty factor of 100. Inhalation RfDs are not available (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "C" - possible human carcinogen based on an increased incidence of skin papillomas in mice in an initiation-promotion study (EPA, 1994a). A quantitative estimate of carcinogenic risk from oral or inhalation exposures is not available (EPA, 1993a, 1994a).

Naphthalene

The chronic oral RfD for naphthalene was 4E-02 mg/kg-d (EPA, 1992a) and was based on a subchronic gavage study in rats. An uncertainty factor of 1,000 was applied to the LOAEL of 35.7 mg/kg-d to obtain the RfD. The critical effect observed in this study was decreased body weight gain. The subchronic oral RfD was also 4E-02 mg/kg-d (EPA, 1992a). These oral RfDs were withdrawn in the November supplement of the 1992 HEAST. However, for the purpose of this HHRA, these values will be used in the HHRA per verbal guidance from EPA Region I. Inhalation RfDs for this constituent are not available at this time (EPA, 1992a, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Naphthalenes, Mono-Substituted Methyl-, Di-Substituted Methyl-, Tri-Substituted Methyl-, Tetra-Substituted Methyl-

Refer to naphthalene.

Perylene

Data are inadequate for quantitative risk assessment and, therefore, no RfDs were found in IRIS or HEAST (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent was not found (EPA, 1994a).

Phenanthrene

The available data is inadequate for quantitative non-cancer risk assessment (EPA, 1993a, 1994a). In the absence of oral RfDs for this constituent, the oral RfDs for naphthalene are cross-assigned.

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Phenanthrenes/Anthracenes, Mono-Substituted Methyl-, Di-Substituted Methyl-, Tri-Substituted Methyl-, Tetra-Substituted Methyl-

Refer to anthracene and phenanthrene.

Phenol

The chronic oral RfD for phenol is 6E-01 mg/kg-d (EPA, 1994a) and is based upon a developmental study in rats. Pregnant CD rats were administered phenol by gavage at doses of 0, 30, 60, and 120 mg/kg-d on gestational days 6 to 15. The LOAEL was 120 mg/kg-d and the critical effect observed was a highly significant reduction in fetal body weights. An uncertainty factor of 100 was applied to the highest fetal NOAEL in this study (60 mg/kg-d) to obtain the RfD. The confidence level in this RfD is low to medium. The subchronic oral RfD is also 6E-01 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

Pyrene

The chronic oral RfD for pyrene is 3E-02 mg/kg-d (EPA, 1994a) and is based on a subchronic gavage study in mice. Mice received 0, 75, 125, or 250 mg/kg-d pyrene by oral gavage for 13 weeks. The LOAEL was 125 mg/kg-d and the critical effects seen were toxic effects to the kidney including changes to the renal tubular pathology and decreased kidney weight. An uncertainty factor of 3000 was applied to the NOAEL of 75 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for inter- and intra-species variability, the use of subchronic rather than chronic data, and the lack of additional supporting data. The confidence level in the RfD is low. The subchronic oral RfD for pyrene is 3E-01 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1994a).

TCDD, 2,3,7,8-

Oral and inhalation RfDs are not available for this constituent (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" (EPA, 1993a). 2,3,7,8-TCDD has been shown to produce liver and respiratory system tumors in a rat dietary study. The oral slope factor is 1.5E+05 $(mg/kg\text{-}d)^{-1}$ (EPA, 1993a). The inhalation slope factor is also 1.5E+05 $(mg/kg\text{-}d)^{-1}$ (EPA, 1993a).

For the purposes of evaluating potential risks to dioxins/furans at the site, these slope factors are used in combination with EPA's (1989d) toxic equivalency factors (TEFs) for the various dioxin/furan congeners. These TEFs include:

Constituent		TEF
Mono-, Di-, and Tri- CDDs:		0
TCDDs:	2,3,7,8-	1
	Other	0
PeCDDs:	2,3,7,8-	0.5
	Other	0
HxCDDs:	2,3,7,8-	0.1
	Other	0
HpCDDs:	2,3,7,8-	0.01
	Other	0
OCDD:		0.001
Mono-, Di-, and Tri- CDFs:		0
TCDFs:	2,3,7,8-	0.1
	Other	0
PeCDFs:	1,2,3,7,8-	0.05
	2,3,4,7,8-	0.5
	Other	0
HxCDFs:	2,3,7,8-	0.1
	Other	0
HpCDFs:	2,3,7,8-	0.01
	Other	0
OCDF:		0.001

B.4 Pesticides

BHC, alpha-

No RfDs were found in either IRIS or HEAST (EPA, 1993a, 1994a). For the purpose of this HHRA, the oral RfDs for gamma-BHC are used for this constituent.

The EPA weight-of-evidence classification for the carcinogenicity of alpha-BHC is "B2" - probable human carcinogen (EPA, 1994a). Alpha-BHC has been shown to induce liver tumors in mice and rats. An oral slope factor of 6.3E+00 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) has been established based upon a dietary study in mice. An inhalation unit risk factor of 1.8E-03 $(\mu g/m^3)^{-1}$ (6.3E+00 $(mg/kg\text{-}d)^{-1}$) has been established (EPA, 1993a, 1994a).

BHC, delta-

Data has been determined to be inadequate for quantitative risk assessment (EPA, 1993a, 1994a), therefore no RfDs were available for this constituent. For the purpose of this HHRA, the oral RfDs for gamma-BHC are used for this constituent.

The EPA weight-of-evidence classification for this constituent is "D" (EPA, 1994a).

BHC, gamma-

The chronic oral RfD for gamma-BHC is 3E-04 mg/kg-d (EPA, 1994a) and is based upon a subchronic oral bioassay in rats. Rats were administered Lindane in the diet at concentrations of 0, 0.2, 0.8, 4, 20 or 100 ppm for 12 weeks. The LOAEL was 20 ppm (converted to 1.55 mg/kg-d) and the critical effects observed were liver and kidney toxicity. An uncertainty factor of 1,000 was applied to the NOAEL of 4 ppm (converted to 0.33 mg/kg-d) to obtain the RfD. The confidence level in this RfD is medium. The subchronic oral RfD is 3E-03 mg/kg-d (EPA, 1993a) and is based on the same study, but applying an uncertainty factor of 100. Inhalation RfDs are not available at this time (EPA, 1993a, 1994a).

The oral slope factor for gamma-BHC is 1.3E+00 mg/kg-d (EPA, 1993a) on the basis of a mouse dietary study. Liver tumors were induced following Lindane administration. The EPA weight-of-evidence classification for the carcinogenicity of gamma-BHC is "B2/C" (EPA, 1993a).

Chlordane, alpha- and gamma-

The chronic oral RfD for chlordane is 6E-05 mg/kg-d (EPA, 1994a) and is based upon a chronic rat feeding study. Rats were fed chlordane at dietary levels of 0, 1, 5 and 25 ppm for 130 weeks. The LOAEL was 5 ppm (converted to 0.273 mg/kg-d) in female rats and the critical effects observed were liver lesions (hypertrophy). An uncertainty factor of 1,000 was applied to the NOEL of 1 ppm (converted to 0.055 mg/kg-d) to obtain the RfD. The confidence level in this RfD is low. The chronic oral RfD was adopted as the subchronic oral RfD (EPA, 1993a). Inhalation RfDs are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of chlordane is "B2" - probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Chlordane has been shown to produce benign and malignant liver tumors in four strains of mice of both sexes and in F344 male rats. An oral slope factor of 1.3E+00 $(mg/kg\text{-}d)^{-1}$ has been established (EPA, 1994a). An inhalation unit risk factor of 3.7E-04 $(\mu g/m^3)^{-1}$ (1.3E+00 $(mg/kg\text{-}d)^{-1}$) has been established (EPA, 1993a, 1994a) based upon the oral data available.

DDD, 4,4-

No RfDs were found in IRIS or HEAST (EPA, 1993a, 1994a).

In this HHRA the oral RfD values for 4,4'-DDT have been assigned to 4,4'-DDD. Inhalation RfDs are not available (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen. This constituent has been shown to produce liver tumors in a dietary study in mice. The oral slope factor for 4,4'-DDD is 2.4E-01 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a). No quantitative estimate of carcinogenic risk from inhalation exposure to this constituent is available (EPA, 1993a, 1994a).

DDE, 4,4-

No RfDs were found in either IRIS or HEAST (EPA, 1993a, 1994a). In this HHRA the oral RfD value for 4,4'-DDT have been assigned to 4,4'-DDE. Inhalation RfDs are not available (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence). This constituent has been shown to produce liver tumors in mice and hamsters and thyroid tumors in female rats. The oral slope factor for 4,4'-DDE is 3.4E-01 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) and is based upon the studies in mice and hamsters. No quantitative estimate of carcinogenic risk from inhalation exposure to this constituent is available (EPA, 1993a, 1994a).

DDT, 4,4'-

The chronic oral RfD for 4,4'-DDT is 5E-04 mg/kg-d (EPA, 1994a) and is based on a subchronic feeding study in rats. Rats received 0, 1, 5, 10, or 50 ppm 4,4'-DDT in their food for 15 to 27 weeks. The LOAEL was 0.25 mg/kg-d (5 ppm diet) and the critical effects seen were histopathological effects to the liver. An uncertainty factor of 100 was applied to the NOAEL of 0.05 mg/kg-d (1 ppm diet) to obtain the RfD. This uncertainty factor was used to account for intra- and inter-species variability. The confidence in the RfD is medium. The subchronic oral RfD for 4,4'-DDT is also 5E-04 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). This constituent has been shown to produce liver tumors in mice and rats. The oral slope factor for 4,4'-DDT is 3.4E-01 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) and is based upon liver tumors in mice and rats following dietary exposure to 4,4'-DDT. On the basis of route-to-route extrapolation, the inhalation slope factor for 4,4'-DDT has been set at 3.4E-01 $(mg/kg\text{-}d)^{-1}$ (9.7E-05 $(\mu g/m^3)^{-1}$ (EPA, 1993a, 1994a).

Dieldrin

The chronic oral RfD for dieldrin is 5E-05 mg/kg-d (EPA, 1994a) and is based upon a two year rat feeding study. Rats were administered dieldrin for 2 years at dietary concentrations of 0, 0.1, 1.0 or 10.0 ppm. The LOAEL was 1.0 ppm (converted to 0.05 mg/kg-d) and the critical effects observed were increased liver weights and liver parenchymal cell changes including focal proliferation and local hyperplasia. An uncertainty factor of 100 was applied to the NOAEL of 0.1 ppm (converted to 0.005 mg/kg-d) to obtain the RfD. The confidence level in this RfD is medium. The chronic oral RfD was adopted as the subchronic oral RfD (EPA, 1993a). Inhalation RfDs for dieldrin are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of dieldrin is "B2" - probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Dieldrin has been shown to be carcinogenic in various strains of mice of both sexes with the effects ranging from benign liver tumors, to hepatocarcinomas to pulmonary metastases. An oral slope factor of 1.6E+01 $(mg/kg\text{-}d)^{-1}$ has been established (EPA, 1994a) on the basis of the above studies. Based on route-to-route extrapolation, the inhalation slope factor has also been set at 1.6E+01 $(mg/kg\text{-}d)^{-1}$ (4.6E-03 $(\mu g/m^3)^{-1}$ (EPA, 1993a, 1994a).

Endosulfan

Endosulfan (CAS #115-29-7), a technical grade material, is a mixture of the two isomers, Endosulfan I (CAS #959-98-8) and Endosulfan II (CAS #33213-65-9). The quantitative risk assessment data presented for Endosulfan is assumed to be representative of the two isomers.

The chronic oral RfD for endosulfan is 6E-03 mg/kg-d (EPA, 1993a) and is based on a 2 year dietary study in rats. The critical effects observed were decreased weight gain, kidney toxicity and aneurysms. The uncertainty factor was 100. The subchronic oral RfD is also 6E-03 mg/kg-d (EPA, 1993a). Inhalation RfDs for this constituent are not available at this time (EPA, 1993a, 1994a).

This constituent has not been evaluated for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Endosulfan Sulfate

No RfDs were found in either IRIS or HEAST (EPA, 1993a, 1994a). For the purposes of this HHRA, the RfDs for endosulfan are used.

The EPA has not evaluated this constituent for evidence of human carcinogenic potential (EPA, 1993a, 1994a).

Endrin

The chronic oral RfD for endrin is 3E-04 mg/kg-d (EPA, 1994a) and is based upon a chronic oral bioassay in dogs. Dogs were fed diets containing 0.1, 0.5, 1.0, 2.0 or 4.0 ppm endrin for 2 years. The LOAEL was 2 ppm (converted to 0.05 mg/kg-d) and the critical effects observed were occasional convulsions, slightly increased relative liver weights and mild histopathological effects in the liver (slight vacuolization of hepatic cells). An uncertainty factor of 100 was applied to the NOAEL of 1 ppm (converted to 0.025 mg/kg-d) to obtain the RfD. The confidence level in this RfD is medium. The chronic oral RfD has been adopted as the subchronic oral RfD (EPA, 1993a). Inhalation RfDs are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to carcinogenicity for humans (EPA, 1994a).

Endrin Aldehyde

Endrin aldehyde has been identified as a metabolite of the parent constituent endrin. No oral or inhalation RfDs were available for endrin aldehyde (EPA, 1993a, 1994a). For the purposes of this HHRA, the RfDs for endrin are used. While the weight-of-evidence classification for the human carcinogenicity of the parent constituent endrin is "D", the EPA has not specifically evaluated the metabolite endrin aldehyde for its human carcinogenic potential (EPA, 1993a, 1994a).

Endrin Ketone

Endrin ketone has been identified as a metabolite of Endrin following microbial degradation in soil. No RfDs for endrin ketone were available in either IRIS or HEAST (1993a, 1994a). For the purposes of this HHRA, the RfDs for endrin are used. While the EPA weight-of-evidence classification for the human carcinogenicity of the parent constituent Endrin is "D", the EPA has not specifically evaluated the metabolite Endrin ketone for its human carcinogenic potential (EPA, 1993a, 1994a).

Heptachlor

The chronic oral RfD for heptachlor is 5E-04 mg/kg-d (EPA, 1994a) and is based on a two year feeding study in rats. Rats were fed diets of 0, 1.5, 3, 5, 7 or 10 ppm of heptachlor for 2 years. The LOAEL was 5 ppm (converted to 0.25 mg/kg-d) and the critical effect observed was increased liver weight. An uncertainty factor of 300 was applied to the NOAEL of 3 ppm (converted to 0.15 mg/kg-d) to obtain the RfD. The confidence level in this RfD is low. The chronic oral RfD was adopted as the subchronic oral RfD (EPA, 1993a). Inhalation RfDs for heptachlor are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1994a). Heptachlor has been shown to produce liver tumors in mice of both sexes. An oral slope factor of 4.5E+00 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) has been established based upon the above studies. An inhalation unit risk factor of 1.3E-03 $(\mu g/m^3)^{-1}$ (4.5E+00 $(mg/kg\text{-}d)^{-1}$) has been calculated from the oral data presented above (EPA, 1993a, 1994a).

Heptachlor Epoxide

The chronic oral RfD for heptachlor epoxide is 1.3E-05 mg/kg-d (EPA, 1994a) and is based on a dietary study in dogs. Beagle dogs were fed diets containing 0, 0.5, 2.5, 5 or 7.5 ppm of heptachlor epoxide for 60 weeks. Liver to body weight ratios were significantly increased in a treatment-related fashion. Effects were noted in both males and females at the LEL of 0.5 ppm. There was no NOEL. An uncertainty factor of 1,000 was applied to the LEL (converted to 0.0125 mg/kg-d) to obtain the RfD. The confidence level in this RfD is low. The chronic oral RfD was adopted as the subchronic oral RfD (EPA, 1993a). Inhalation RfDs are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "B2" - probable human carcinogen. Heptachlor epoxide has been shown to induce liver carcinomas in mice of both sexes and in CFN female rats. The oral slope factor for heptachlor epoxide is 9.1E+00 $(mg/kg\text{-}d)^{-1}$ (EPA, 1994a) and is based on the induction of hepatocellular carcinomas in male and female C3H mice and male and female CD-1 mice. An inhalation unit risk factor of 2.6E-03 $(\mu g/m^3)^{-1}$ (9.1E+00 $(mg/kg\text{-}d)^{-1}$) was also calculated from the oral data (EPA, 1993a, 1994a).

Methoxychlor

The chronic oral RfD for methoxychlor is 5E-03 mg/kg-d (EPA, 1994a) and is based upon a teratology study in rabbits. Pregnant rabbits were administered methoxychlor at doses of 5.01, 35.5 or 251.0 mg/kg-d on days 7 through 19 of gestation. The LOAEL was 35.5 mg/kg-d and the critical effect observed was an excessive loss of litters (abortions). An uncertainty factor of 1,000 was applied to the NOEL of 5.01 mg/kg-d to obtain the RfD. The confidence in this oral RfD is low. The chronic oral RfD was adopted as the subchronic oral RfD (EPA, 1993a). Inhalation RfDs are not available at this time (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to carcinogenicity for humans (EPA, 1994a).

B.5 PCBs

PCBs

EPA (1993a, 1994a) has not established oral or inhalation RfDs for any individual Aroclor or for PCBs combined.

The EPA weight-of-evidence classification for the carcinogenicity of PCBs is "B2" - probable human carcinogen (sufficient animal evidence, inadequate/no human evidence (EPA, 1994a). PCBs have been shown to produce liver tumors in rats and mice. In humans, the available data are inadequate but provide suggestive evidence of excess risk of liver cancer from ingestion and inhalation or dermal contact. An oral slope factor of 7.7 $(mg/kg\text{-}d)^{-1}$ has been established for PCBs (EPA, 1994a) based on a dietary study in rats. Liver lesions and carcinomas were observed in rats exposed to 100 ppm Aroclor 1260 in corn oil for 16 months, followed by 50 ppm exposure for 8 months and a basal diet for 5 months. A quantitative estimate of carcinogenic risk from inhalation exposure is not available (EPA, 1993a, 1994a).

B.6 Butyltins

Tributyltin

Data are inadequate for quantitative risk assessment and, therefore, no RfDs were found in IRIS or HEAST (EPA, 1993a, 1994a).

The EPA weight-of-evidence classification for the carcinogenicity of this constituent was not found (EPA, 1993a, 1994a).

APPENDIX C

IEUBK Lead Model Resulsts

HARD SHELL CLAMS RME

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

Diet: alternate diet selected by user as follows:

Home-grown Fruit:	0.000 ug Pb/g	0.0 %
Home-grown Vegetables:	0.000 ug Pb/g	0.0 %
Recreational Fish:	0.420 ug Pb/g	4.0 %
Wild Game:	0.000 ug Pb/g	0.0 %

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

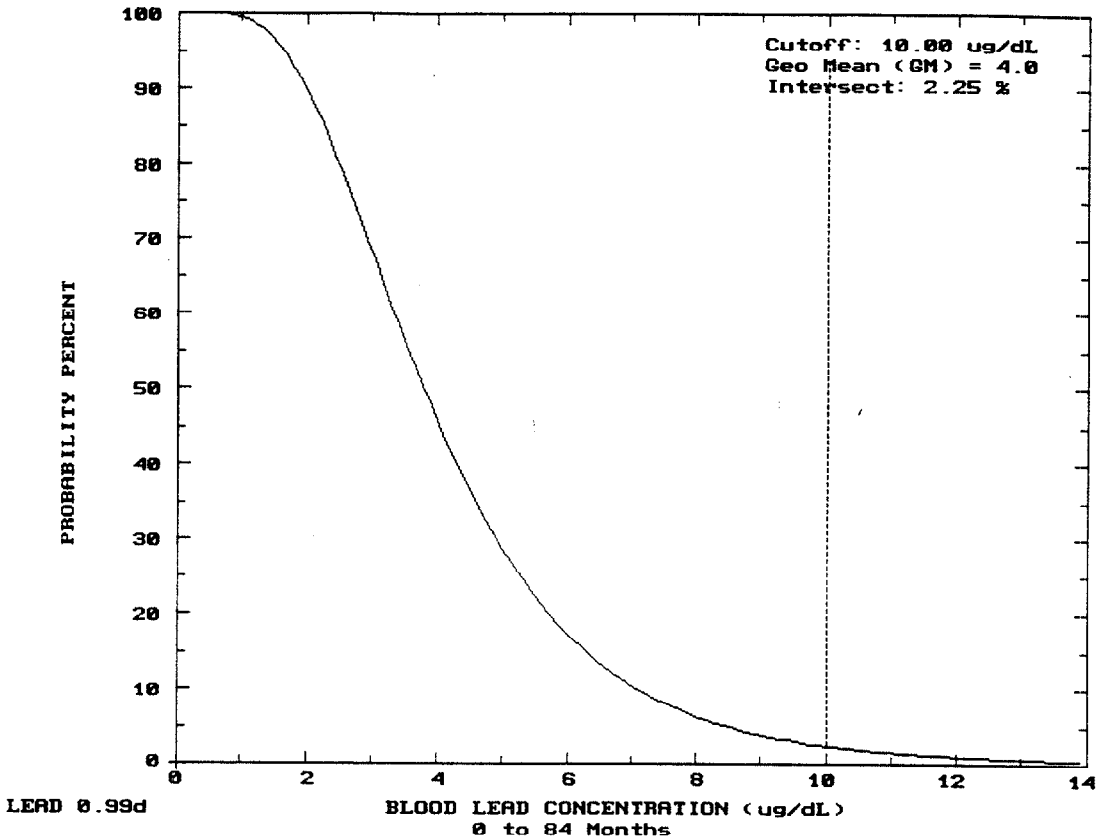
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.3	7.95	4.66
1-2:	4.8	11.58	7.31
2-3:	4.5	12.23	7.39
3-4:	4.3	12.35	7.49
4-5:	3.7	10.60	5.66

5-6:	3.3	10.42	5.14	
6-7:	3.0	10.60	4.87	

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.91	0.37	0.00	0.02
1-2:	3.32	0.90	0.00	0.03
2-3:	3.82	0.95	0.00	0.06
3-4:	3.81	0.98	0.00	0.07
4-5:	3.83	1.04	0.00	0.07
5-6:	4.08	1.10	0.00	0.09
6-7:	4.52	1.13	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 4.0
Intersect: 2.25 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

HARD SHELL CLAMS CTE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

Diet: alternate diet selected by user as follows:

Home-grown Fruit:	0.000 ug Pb/g	0.0 %
Home-grown Vegetables:	0.000 ug Pb/g	0.0 %
Recreational Fish:	0.190 ug Pb/g	4.0 %
Wild Game:	0.000 ug Pb/g	0.0 %

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

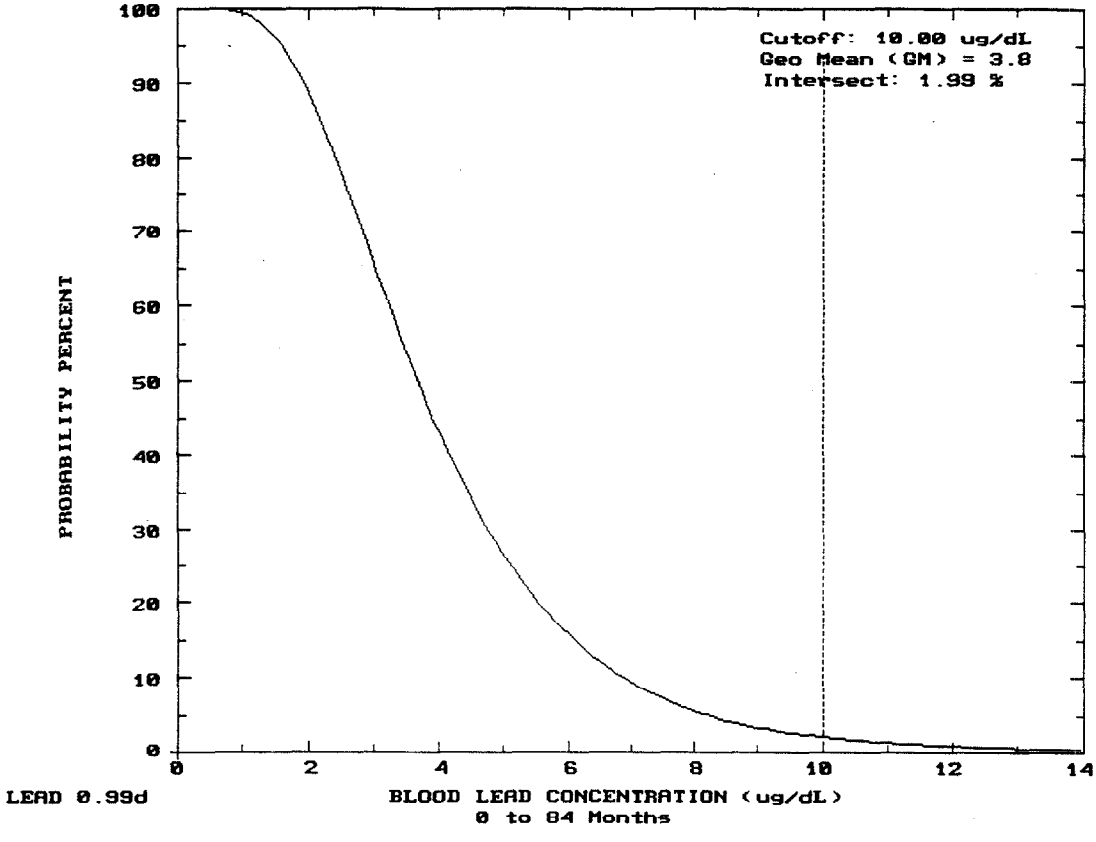
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.2	7.84	4.66
1-2:	4.7	11.25	7.34
2-3:	4.4	11.86	7.41
3-4:	4.2	11.94	7.51
4-5:	3.6	10.16	5.68

5-6:	3.1	9.95	5.15	
6-7:	2.9	10.09	4.88	

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.79	0.37	0.00	0.02
1-2:	2.97	0.91	0.00	0.03
2-3:	3.43	0.95	0.00	0.06
3-4:	3.39	0.98	0.00	0.07
4-5:	3.38	1.04	0.00	0.07
5-6:	3.60	1.11	0.00	0.09
6-7:	3.99	1.13	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 3.8
Intersect: 1.99 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

BLUE MUSSEL RME

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

Diet: alternate diet selected by user as follows:

Home-grown Fruit:	0.000 ug Pb/g	0.0 %
Home-grown Vegetables:	0.000 ug Pb/g	0.0 %
Recreational Fish:	0.810 ug Pb/g	4.0 %
Wild Game:	0.000 ug Pb/g	0.0 %

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

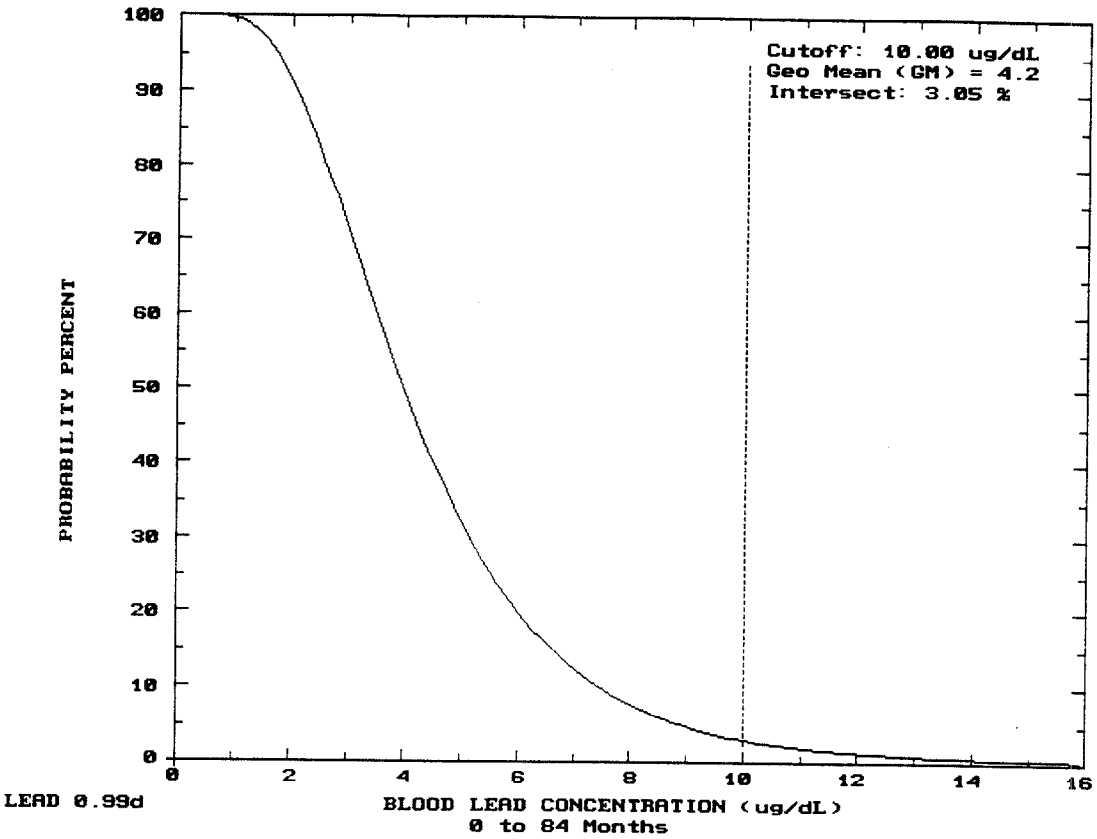
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.4	8.14	4.65
1-2:	5.0	12.13	7.28
2-3:	4.8	12.85	7.36
3-4:	4.5	13.02	7.46
4-5:	3.9	11.35	5.64

5-6:	3.5	11.20	5.12	
6-7:	3.2	11.46	4.85	

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	3.11	0.36	0.00	0.02
1-2:	3.92	0.90	0.00	0.03
2-3:	4.48	0.94	0.00	0.06
3-4:	4.52	0.98	0.00	0.07
4-5:	4.61	1.03	0.00	0.07
5-6:	4.89	1.10	0.00	0.09
6-7:	5.39	1.12	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 4.2
Intersect: 3.05 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

BLUE MUSSEL CTE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

Diet: alternate diet selected by user as follows:

Home-grown Fruit:	0.000 ug Pb/g	0.0 %
Home-grown Vegetables:	0.000 ug Pb/g	0.0 %
Recreational Fish:	0.230 ug Pb/g	4.0 %
Wild Game:	0.000 ug Pb/g	0.0 %

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

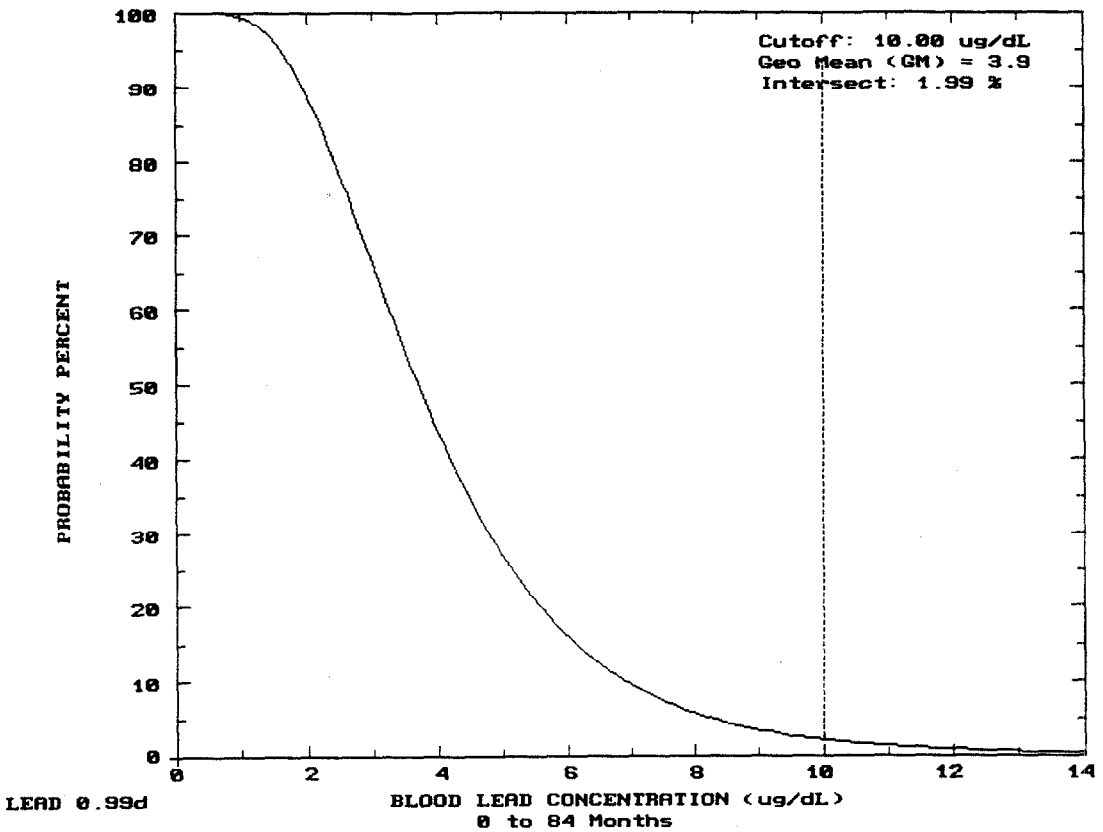
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.2	7.86	4.66
1-2:	4.7	11.30	7.33
2-3:	4.4	11.92	7.41
3-4:	4.2	12.01	7.50
4-5:	3.6	10.24	5.67

5-6:	3.2	10.03	5.15
6-7:	2.9	10.18	4.88

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.81	0.37	0.00	0.02
1-2:	3.03	0.91	0.00	0.03
2-3:	3.50	0.95	0.00	0.06
3-4:	3.46	0.98	0.00	0.07
4-5:	3.46	1.04	0.00	0.07
5-6:	3.69	1.11	0.00	0.09
6-7:	4.08	1.13	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 3.9
Intersect: 1.99 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LOBSTER RME

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

Diet: alternate diet selected by user as follows:

Home-grown Fruit:	0.000 ug Pb/g	0.0 %
Home-grown Vegetables:	0.000 ug Pb/g	0.0 %
Recreational Fish:	0.110 ug Pb/g	4.0 %
Wild Game:	0.000 ug Pb/g	0.0 %

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

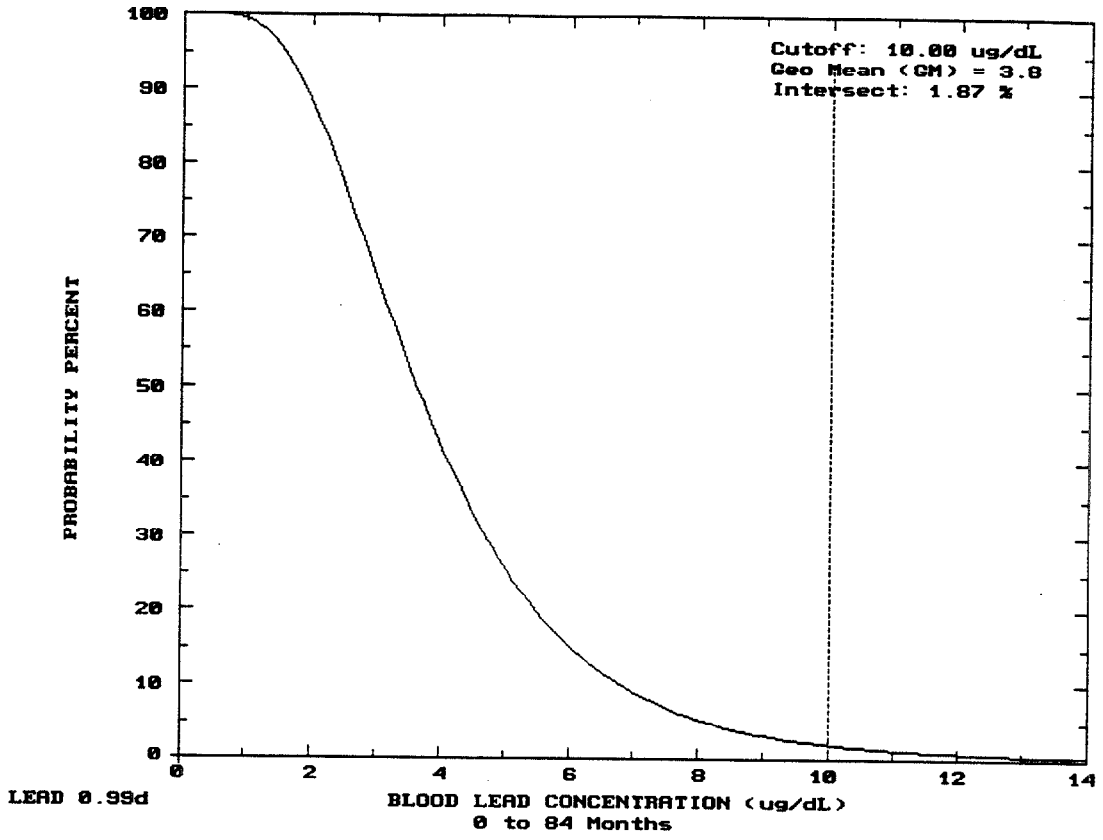
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.2	7.80	4.67
1-2:	4.6	11.13	7.34
2-3:	4.3	11.73	7.42
3-4:	4.1	11.80	7.52
4-5:	3.5	10.01	5.68

5-6:	3.1	9.79	5.15	
6-7:	2.8	9.92	4.88	

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.74	0.37	0.00	0.02
1-2:	2.85	0.91	0.00	0.03
2-3:	3.29	0.95	0.00	0.06
3-4:	3.24	0.98	0.00	0.07
4-5:	3.22	1.04	0.00	0.07
5-6:	3.43	1.11	0.00	0.09
6-7:	3.81	1.13	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 3.8
Intersect: 1.87 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

LOBSTER CTE

LEAD MODEL Version 0.99d

AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

Diet: alternate diet selected by user as follows:

Home-grown Fruit:	0.000 ug Pb/g	0.0 %
Home-grown Vegetables:	0.000 ug Pb/g	0.0 %
Recreational Fish:	0.040 ug Pb/g	4.0 %
Wild Game:	0.000 ug Pb/g	0.0 %

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	200.0	200.0
1-2	200.0	200.0
2-3	200.0	200.0
3-4	200.0	200.0
4-5	200.0	200.0
5-6	200.0	200.0
6-7	200.0	200.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT

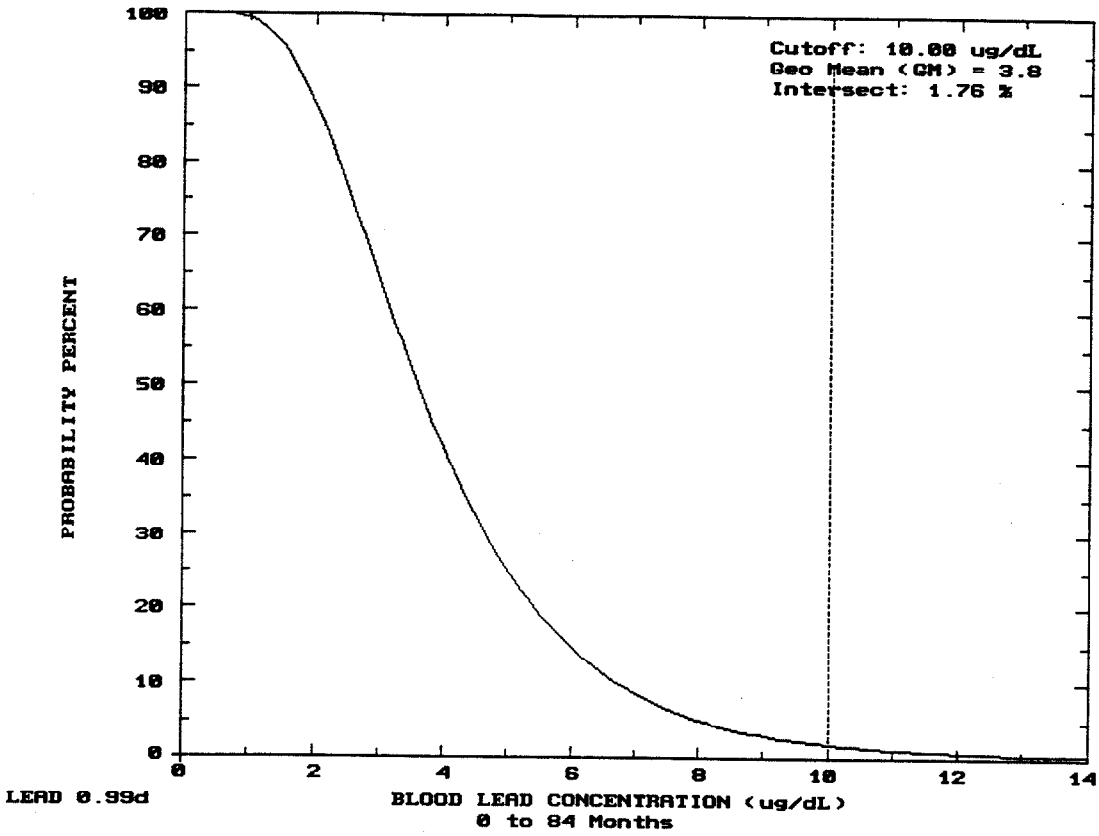
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	4.2	7.76	4.67
1-2:	4.6	11.03	7.35
2-3:	4.3	11.61	7.43
3-4:	4.1	11.68	7.52
4-5:	3.5	9.87	5.69

5-6:	3.0	9.64	5.16	
6-7:	2.8	9.76	4.88	

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.71	0.37	0.00	0.02
1-2:	2.74	0.91	0.00	0.03
2-3:	3.17	0.95	0.00	0.06
3-4:	3.11	0.98	0.00	0.07
4-5:	3.08	1.04	0.00	0.07
5-6:	3.29	1.11	0.00	0.09
6-7:	3.65	1.13	0.00	0.09


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 3.8
Intersect: 1.76 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
0 to 84 Months

APPENDIX D

Analytical Data for Indigenous Blue Mussels and Deployed Blue Mussels

Notes On Appendix D

The data expressed in this appendix is data that was reported by URIGSO in The Final Ecological Risk Assessment for Derecktor Shipyard (Appendix A), May 1997. This data has been converted to wet weight units based on the moisture content of the samples.

Data is presented for Blue Mussels, both indigenous (IBM) and those collected in Eastern Massachusetts and deployed at the site for a period of 60 days. The "T0" (time zero) sample is a fraction of the deployed mussels that was not deployed at the site, thus it is a control sample for the deployment group.

The concentrations are qualified from the validation as follows:

ND - Actual concentration was not detected value provided is the detection limit calculated for that sample.

NC - Concentration could not be calculated.

J - Contaminant was detected, but quantification is estimated.

I - Interference in the sample matrix did not allow quantification of the analyte

Z - Value is calculated.

U - Analyte was not detected: value provided is the detection limit calculated for that sample.

Units: Data is expressed as ng/g for organic compounds, which is equivalent to ug/kg, and ug/g for metals, which is equivalent to mg/kg.

ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	CHC-1-DM		CHC-1-IBM		DSY-24-IBM		DSY-25-IBM		DSY-26-DM		DSY-26-IBM		DSY-27-IBM		DSY-28-DM		DSY-28-IBM	
Sample Location	CHC-1		CHC-1		DSY-24		DSY-25		DSY-26		DSY-26		DSY-27		DSY-28		DSY-28	
Date Sampled																		
Description																		
Matrix	Deployed Mussels		Mussels		Mussels		Mussels		Deployed Mussels		Mussels		Mussels		Deployed Mussels		Mussels	
Polyaromatic Hydrocarbons (PAH) (ng/g)																		
1,6,7-Trimethylnaphthalene	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	2.68247		0.5257	U	0.5257	U
1-Methylnaphthalene	3.104542		0.7938	U		I	2.081548		0.7938	U	0.7938	U	0.7938	U	0.7938	U	0.7938	U
1-Methylphenanthrene	2.130996	J	1.267	U	1.192254	J	3.640532		1.267	U	5.087166		6.9643		1.267	U	1.267	U
2,6-Dimethylnaphthalene	9.91242		3.10198		6.142234		1.9327		3.773098		2.252278		3.458546		0.735	U	0.735	U
2-Methylnaphthalene	7.758324		1.316	U		I	3.930346		1.316	U	1.316	U	1.316	U	1.316	U	1.316	U
Acenaphthene	7.721294		0.371	U	0.371	U	2.19268		9.42319		0.371	U	0.371	U	0.371	U	0.371	U
Acenaphthylene	5.58446		2.44552		1.611134		10.430126		6.93287		12.531904		8.275666		0.4039	U	4.869424	
Anthracene	5.99039		3.51316		2.481598		25.745986		9.096136		33.190906		23.347674		3.315578		9.546054	
Benzo(a)anthracene	6.354124		6.62354		2.135588		39.272366		10.585134		145.61148		40.559778		5.916232		10.047338	
Benzo(a)pyrene	3.04318		4.339314		1.107246		16.033346		0.5061	U	76.726482		10.234532		0.5061	U	4.739798	
Benzo(b,j,k)fluoranthene	13.277558		15.347976		6.06151		77.188664		16.747598		323.4		55.024144		10.73457		17.862866	
Benzo(e)pyrene	9.449776		12.055792		5.171684		38.427928		12.408116		114.800812		32.73739		8.509956		15.105524	
Benzo(g,h,i)perylene	0.2177	U	4.255692		2.917768		6.728148		0.2177	U	20.665694		4.087888		0.2177	U	0.2177	U
Biphenyl	0.798	U	0.798	U	0.798	U	1.628088		0.798	U	0.798	U	1.805272		0.798	U	0.798	U
Chrysene	5.049716		6.928936		2.906848		42.163618		9.582944		87.612014		41.610198		4.11558		12.024082	
Dibenz(a,h)anthracene	2.96569		0.0686	U	1.109192		1.895152		0.0686	U	6.954248		0.0686	U	0.0686	U	0.0686	U
Fluoranthene	14.466284		11.884656		8.251222		103.680192		48.003732		183.4		162.4		16.266376		34.41011	
Fluorene	0.273	U	2.338336		0.963844		4.15702		0.273	U	4.672136		5.480636		0.273	U	3.520272	
High Molecular Weight PAHs	44.287348	Z	40.190136	Z	22.262744	Z	273.757218	Z	106.644076	Z	645.904238	Z	369.525898	Z	43.202614	Z	85.83736	Z
Indeno(1,2,3-cd)pyrene	0.2156	U	2.17168		1.66173		4.965114		0.2156	U	16.929542		3.749564		0.2156	U	0.2156	U
Low Molecular Weight PAHs	31.87933	Z	14.281036	Z	8.774444	Z	86.67673	Z	38.159576	Z	109.454016	Z	77.173264	Z	12.065872	Z	35.822654	Z
Naphthalene	0.2352	U	0.2352	U		I	18.999862		0.2352	U	25.638774		0.2352	U	0.2352	U	0.2352	U
Perylene	5.413898			I		I	11.474568		0.49	U	25.784304			I	0.49	U		I
Phenanthrene	4.316648		4.061834		3.346868		21.220724		10.883166		31.733282		38.147088		6.151194		15.964718	
Pyrene	12.408354		10.34509		6.752648		70.71253		37.897552		145.6		114.652776		16.32974		24.547432	
Total Polycyclic Aromatic Hydrocarbons	118.947654	Z	89.413492	Z	53.813368	Z	508.2	Z	175	Z	1262.8	Z	555.8	Z	71.339212	Z	152.6	Z
PCB Congener (ng/g)																		
101 (2 2'3 5 5')	2.3604		2.32316		3.8948		3.55516		5.54456		5.78046		7.94962		5.25308		5.68162	
105 (2 3 3'4 4')	0.490364	J	0.48076	J	0.663404	J	0.554806	J	73.96018		1.014804	J	1.3489		1.45243		0.8988	J
118 (2 3'4 4'5)	2.961672		2.706592		2.943052		2.690212		4.327568		4.14386		6.236454		5.44978		3.67934	
128 (2 2'3 3'4 4')	1.383662		1.851458		2.021866		1.112342		1.646512		2.294614		2.732982		1.70401		1.620584	
138 (2 2'3 4 4'5)	4.822118		4.46908		8.464008		6.560022		9.774002		12.27758		17.610152		9.197678		11.746308	
153 (2 2'4 4'5 5')	6.83774		6.73092		12.815838		9.772742		11.541418		17.445442		24.198342		11.663428		16.672782	
170 (2 2'3 3'4 4'5)	0.459564		0.261128		0.66073		0.223468		1.16228		0.36057		0.638988		0.502586		0.523852	
18 (2 2'5)	0.455	U	0.455	U	0.392784	J	0.455	U	2.363578		0.382424	J	0.874412	J	0.455	U	0.455	U

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	CHC-1-DM		CHC-1-IBM		DSY-24-IBM		DSY-25-IBM		DSY-26-DM		DSY-26-IBM		DSY-27-IBM		DSY-28-DM		DSY-28-IBM	
Sample Location	CHC-1		CHC-1		DSY-24		DSY-25		DSY-26		DSY-26		DSY-27		DSY-28		DSY-28	
Date Sampled																		
Description																		
Matrix	Deployed Mussels		Mussels		Mussels		Mussels		Deployed Mussels		Mussels		Mussels		Deployed Mussels		Mussels	
180 (2 2'3 4 4'5 5')	1.249276		0.679154		1.639092		1.175244		2.67456		1.692278		3.865484		2.17805		2.364068	
187 (2 2'3 4'5 5'6)	1.673924		1.9635		4.083856		3.309166		3.59009		5.69072		7.802774		3.548902		5.314624	
195 (2 2'3 3'4 4'5 6)	0.258734		0.176428		0.056	U	0.165172		0.199388		0.056	U	0.131698		0.240646		0.41608	
206 (2 2'3 3'4 4'5 5'6)	0.259448		0.532756		0.44093		0.275884		0.522928		0.767886		0.31409		0.696318		0.50883	
209 (2 2'3 3'4 4'5 5'6 6')	0.262934		0.61565		0.657594		0.21483		0.463302		0.579712		0.08883	J	0.589638		1.162056	
28 (2 4 4')	1.067682		2.294824		0.809648		1.991934		1.426376		2.293914		1.42149		1.55491		1.38474	
44 (2 2'3 5')	0.656334		0.0532	U	0.937132		0.776412		1.894116		1.12217		1.547308		1.591814		0.83258	
52 (2 2'5 5)	1.98422		1.78962		1.635494		2.97556		2.86027		1.992564		2.778874		2.229262		3.059574	
66 (2 3'4 4')	0.5397	U	0.5397	U	0.5397	U	0.576996	J	0.5397	U	0.5397	U	0.5397	U	0.5397	U	0.5397	U
8 (2 4)	0.28693	J	0.328076	J	1.021076		1.049426		0.348614	J	0.346752	J	0.859754		0.384776	J	0.263424	J
PCB Sum of Congeners	27.014988		27.203092		43.081304		36.97939		124.299742		58.18575		80.40018		48.23728		56.129206	
PCB Sum of Congeners x 2	54.02999	Z	54.406198	Z	86.162594	Z	73.95878	Z	249.2	Z	116.371514	Z	161	Z	96.474574	Z	112.258426	Z
Butyltins (ng Sn/g)																		
Dibutyltin	0.42	U	2.1378		0.42	U	0.42	U	0.42	U	0.42	U	5.7232		0.42	U	0.42	U
Monobutyltin	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U
Tetrabutyltin	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U
Tributyltin	5.6952		9.3184		1.8928		3.5056		4.5794		2.7832		136.7814		1.54		6.8712	
Metals (ug/g)																		
Aluminum	8.5526		8.3468		20.4022		7.8694		11.8328		25.4716		52.1668		10.9802		14.903	
Arsenic	1.0472		0.6552		1.4308		1.7584		0.7448		1.1508		0.9352		2.3576		0.3752	
Cadmium	0.1036		0.0812		0.2604		0.1694		0.1316		0.1022		0.1078		0.1078		0.0868	
Chromium	0.245		0.2576		0.441		0.42		0.3024		0.3416		0.4004		0.3332		0.3556	
Copper	1.5456		1.6702		0.5824		1.6716		1.8592		1.0766		2.086		1.5372		0.1582	
Iron	22.2572		26.9024		61.2066		29.5148		24.647		42.126		51.674		26.943		15.092	
Lead	0.3626		0.1092		0.8134		0.000042	U	0.1904		0.000042	U	0.4228		0.000042	U	0.000042	U
Manganese	0.693		0.6972		2.4276		1.5736		0.9772		0.7826		4.4576		2.0174		5.3648	
Mercury	0.022302		0.025802		0.039088		0.024444		0.02268		0.016576		0.020706		0.018732		0.020202	
Nickel	0.5754		0.5376		0.7616		0.4802		0.2548		0.000042	U	0.6636		0.6818		0.000042	U
Silver	0.000014	U	0.000014	U	0.000014	U	0.000014	U	0.000014	U	0.000014	U	0.000014	U	0.1652		0.000014	U
Zinc	10.4496		12.8352		10.6862		15.7402		14.4088		12.7358		19.9178		13.335		16.891	

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-29-DM		DSY-29-LOB		DSY-31-DM		DSY-33-DM		DSY-35-IBM		DSY-36-IBM		DSY-38-DM		DSY-39-DM	
Sample Location	DSY-29		DSY-29		DSY-31		DSY-33		DSY-35		DSY-36		DSY-38		DSY-39	
Date Sampled																
Description																
Matrix	Deployed Mussels		Lobster		Deployed Mussels		Deployed Mussels		Mussels		Mussels		Deployed Mussel		Deployed Mussel	
Polyaromatic Hydrocarbons (PAH) (ng/g)																
1,6,7-Trimethylnaphthalene	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U
1-Methylnaphthalene	0.7938	U	1.378832	J	0.7938	U	0.7938	U	0.7938	U		I		I	0.7938	U
1-Methylphenanthrene	1.267	U	11.036494		1.267	U	1.267	U	1.38509	J	0.950124	J	1.267	U	1.267	U
2,6-Dimethylnaphthalene	6.600958		0.735	U	0.735	U	0.735	U	2.695406		0.638232	J	0.890554	J	1.832488	
2-Methylnaphthalene	1.316	U	2.083774	J	1.316	U	1.316	U	1.316	U		I		I	1.316	U
Acenaphthene	21.07497		0.371	U	0.371	U	0.371	U	0.371	U	0.371	U	0.371	U	9.437694	
Acenaphthylene	4.36947		0.4039	U	0.4039	U	0.4039	U	0.4039	U	2.141664		1.664502		4.550896	
Anthracene	5.63388		1.12	U	4.67705		1.12	U	3.566794		4.059566		1.666392	J	1.12	U
Benzo(a)anthracene	7.512582		0.4704	U	8.249416		0.4704	U	4.3554		4.236092		2.070824		2.486428	
Benzo(a)pyrene	0.5061	U	1.831956		0.5061	U	0.5061	U	0.5061	U	1.754298		1.129338		0.5061	U
Benzo(b,j,k)fluoranthene	9.936024		3.310454		12.50186		0.868	U	9.244662		9.933		4.571714		0.868	U
Benzo(e)pyrene	8.30445		1.35226		6.38897		0.546	U	7.316372		6.799114		4.305616		6.213186	
Benzo(g,h,i)perylene	0.2177	U	1.773366		0.2177	U	0.2177	U	1.980468		1.40798		0.2177	U	3.231102	
Biphenyl	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U
Chrysene	5.229252		0.7364	U	5.356106		0.7364	U	5.633712		5.67336		2.015734		2.757384	
Dibenz(a,h)anthracene	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U	4.641658	
Fluoranthene	23.910194		5.464074		16.627282		12.227642		14.67585		14.715358		5.456822		5.7267	
Fluorene	0.273	U	2.088296		0.273	U	0.273	U	1.626128		0.70112		0.273	U	0.273	U
High Molecular Weight PAHs	60.077164	Z	18.299344	Z	47.239038	Z	26.38293	Z	36.237586	Z	38.388308	Z	16.790956	Z	22.181208	Z
Indeno(1,2,3-cd)pyrene	0.2156	U	1.47945		0.2156	U	0.2156	U	1.453214		0.838754		0.2156	U	3.900106	
Low Molecular Weight PAHs	39.53236	Z	12.730298	Z	13.014736	Z	5.0421	Z	13.357918	Z	11.237366	Z	6.5618	Z	18.25579	Z
Naphthalene	0.2352	U	2.719248		0.2352	U	0.2352	U	0.2352	U		I		I	0.2352	U
Perylene	0.49	U	0.49	U	0.49	U	0.49	U		I		I	0.202258	J	0.49	U
Phenanthrene	6.629854		3.94408		5.738586		1.323	U	5.838896		3.964016		2.58692	J	1.323	U
Pyrene	22.85045		9.727914		16.431534		12.373788		10.997924		11.940586		6.049652		6.062924	
Total Polycyclic Aromatic Hydrocarbons	122.05207	Z	48.16	Z	75.97079	Z	24.60143	Z	70.76993	Z	69.753278	Z	32.610312	Z	50.840594	Z
PCB Congener (ng/g)																
101 (2 2'3 5 5')	4.46894		1.3041		6.83298		4.97476		4.84932		5.58544		3.94506		3.42496	
105 (2 3 3'4 4')	17.64875		0.462714	J	1.495578		0.87591	J	0.847098	J	0.893508	J	0.78659	J	1.05658	J
118 (2 3'4 4'5)	4.100278		2.084726		6.346256		5.492802		3.712688		4.09248		3.458966		2.28438	
128 (2 2'3 3'4 4')	1.54231		0.495264		1.63184		1.44725		2.835504		2.78138		1.121372		1.016204	
138 (2 2'3 4 4'5)	8.38509		3.62712		9.415112		8.48589		10.32948		14.04137		6.82675		5.88861	
153 (2 2'4 4'5 5')	10.981754		4.961474		13.419924		12.060286		14.514458		20.21537		10.004176		8.203006	
170 (2 2'3 3'4 4'5)	0.603218		0.91245		0.490742		0.521962		0.23828		0.504224		0.625156		0.442232	
18 (2 2'5)	0.455	U	0.57799	J	0.455	U	0.203518	J	0.455	U	0.455	U	0.455	U	0.455	U

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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-29-DM		DSY-29-LOB		DSY-31-DM		DSY-33-DM		DSY-35-IBM		DSY-36-IBM		DSY-38-DM		DSY-39-DM	
Sample Location	DSY-29		DSY-29		DSY-31		DSY-33		DSY-35		DSY-36		DSY-38		DSY-39	
Date Sampled																
Description																
Matrix	Deployed Mussels		Lobster		Deployed Mussels		Deployed Mussels		Mussels		Mussels		Deployed Mussel		Deployed Mussel	
180 (2 2'3 4 4'5 5')	2.408826		1.988518		2.219938		2.152206		1.576274		2.4521		1.78801		1.432592	
187 (2 2'3 4'5 5'6)	3.350074		1.908592		3.802162		3.665858		5.179482		6.722758		2.893464		2.213834	
195 (2 2'3 3'4 4'5 6)	0.221312		0.600908		0.27321		0.142296		0.056	U	0.056	U	0.400064		0.215586	
206 (2 2'3 3'4 4'5 5'6)	0.510818		0.888314		0.79205		0.258958		0.360206		0.408548		0.696948		0.76594	
209 (2 2'3 3'4 4'5 5'6 6')	0.574518		0.798882		0.658574		0.058282	J	0.370412		0.466438		1.56443		0.759472	
28 (2 4 4')	0.91315		0.899766		1.152424		0.735126		1.258488		1.233736		0.89453		0.940282	
44 (2 2'3 5')	1.474942		0.047642	J	2.235912		1.372042		0.877296		0.969318		1.156148		1.22689	
52 (2 2'5 5)	2.896572		1.71157		3.805718		1.778056		1.466556		1.794688		1.967882		2.073554	
66 (2 3'4 4')	0.5397	U	1.590806		0.5397	U	0.5397	U	0.5397	U	0.5397	U	0.5397	U	0.5397	U
8 (2 4)	0.66773		0.329	U	0.426566	J	0.447314	J	0.307244	J	0.46557	J	0.300776	J	0.293846	J
PCB Sum of Congeners	60.748296		24.86085		54.998972		44.672516		48.722772		62.626942		38.43035		32.237982	
PCB Sum of Congeners x 2	121.496592	Z	49.7217	Z	109.997944	Z	89.345032	Z	97.445544	Z	125.253884	Z	76.860714	Z	64.47595	Z
Butyltins (ng Sn/g)																
Dibutyltin	0.42	U	0.42	U	0.42	U	0.42	U	0.42	U	0.42	U	0.42	U	0.42	U
Monobutyltin	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U
Tetrabutyltin	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U
Tributyltin	2.527		0.42	U	1.33		2.8784		1.2852		4.9672		1.1648		1.3524	
Metals (ug/g)																
Aluminum	9.5802		0.007	U	11.1468		14.1288		11.459		11.8384		12.3634		15.0808	
Arsenic	1.2516		3.9984		0.7294		1.7402		0.8722		0.861		0.8512		1.2516	
Cadmium	0.1134		0.0658		0.0756		0.1302		0.1022		0.0546		0.0868		0.0448	
Chromium	0.2828		0.2394		0.3206		0.3542		0.3108		0.3976		0.3668		0.4186	
Copper	0.8848		14.0532		1.2474		1.1816		1.05		0.9856		1.6016		1.2026	
Iron	16.5522		3.9172		27.3448		40.3564		28.6482		27.6248		52.8038		20.02	
Lead	0.1316		0.0308		0.1876		0.2058		0.245		0.000042	U	0.2702		0.000042	U
Manganese	2.6348		0.2436		1.8074		0.8008		0.3808		1.5778		2.191		1.8774	
Mercury	0.023702		0.040236		0.020356		0.014266		0.023226		0.026418		0.017948		0.019726	
Nickel	0.4018		0.2436		0.2898		0.2436		0.000042	U	0.6062		0.4074		0.4676	
Silver	0.000014	U	0.8176		0.000014	U	0.000014	U	0.000014	U	0.000014	U	0.2408		0.1372	
Zinc	10.4916		18.1174		22.9446		17.0576		18.144		11.8384		12.5146		18.2868	

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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-40-DM		DSY-40-IBM		JPC-1-DM		JPC-1-IBM		T0-DM	
Sample Location	DSY-40		DSY-40		JPC-1		JPC-1		T-0	
Date Sampled										
Description										
Matrix	Deployed Mussel		Mussels		Deployed Mussels		Mussels		Deployed Mussel Control	
Polyaromatic Hydrocarbons (PAH) (ng/g)										
1,6,7-Trimethylnaphthalene	0.5257	U	0.5257	U	0.5257	U	0.5257	U	0.5257	U
1-Methylnaphthalene	0.7938	U	0.7938	U	0.7938	U		I		I
1-Methylphenanthrene	1.267	U	1.267	U	1.267	U	1.267	U	1.267	U
2,6-Dimethylnaphthalene	4.570888		0.735	U	0.735	U	0.735	U	0.735	U
2-Methylnaphthalene	1.316	U	1.316	U	1.316	U		I		I
Acenaphthene	18.320652		0.371	U	9.0132		0.371	U	0.371	U
Acenaphthylene	6.95366		3.169992		0.4039	U	1.584198		0.4039	U
Anthracene	5.732034		4.780734		3.04066		1.650978	J	0.838754	J
Benzo(a)anthracene	5.896394		3.455662		2.312814		2.211342		0.4704	U
Benzo(a)pyrene	0.5061	U	0.873012	J	0.5061	U	1.093904		0.845362	J
Benzo(b,j,k)fluoranthene	0.868	U	7.765282		5.019462		5.006624		1.512532	J
Benzo(e)pyrene	6.79917		6.580014		4.474442		3.694348		1.912106	
Benzo(g,h,i)perylene	0.2177	U	0.2177	U	0.2177	U	0.2177	U	0.2177	U
Biphenyl	0.798	U	0.798	U	0.798	U	0.798	U	0.798	U
Chrysene	3.186974		4.128558		1.95496		2.366966		0.7364	U
Dibenz(a,h)anthracene	0.0686	U	0.0686	U	0.0686	U	0.0686	U	0.0686	U
Fluoranthene	20.16679		14.762762		6.735932		6.470828		2.226742	J
Fluorene	0.273	U	2.008118		0.273	U	0.90412		0.861532	
High Molecular Weight PAHs	47.16467	Z	34.694926	Z	19.487902	Z	17.106642	Z	6.21474	Z
Indeno(1,2,3-cd)pyrene	0.2156	U	0.2156	U	0.2156	U	0.2156	U	0.2156	U
Low Molecular Weight PAHs	42.477106	Z	22.064224	Z	18.170096	Z	6.994736	Z	6.671672	Z
Naphthalene	0.2352	U	2.11106		0.2352	U		I		I
Perylene	0.49	U		I	0.49	U		I		I
Phenanthrene	9.646546		8.30732		3.888136		2.48444	J	4.196472	
Pyrene	17.339798		11.406332		7.909496		4.895016		1.867236	
Total Polycyclic Aromatic Hydrocarbons	98.61292	Z	69.348846	Z	44.349102	Z	32.36275	Z	14.26075	Z
PCB Congener (ng/g)										
101 (2 2'3 5 5')	4.1461		6.1775		3.69054		3.5175		3.12998	
105 (2 3 3'4 4')	0.68817	J	1.107652	J	8.361304		0.493472	J	0.300678	J
118 (2 3'4 4'5)	3.382358		4.919726		3.120096		2.420362		0.65023	J
128 (2 2'3 3'4 4')	1.621774		3.220644		1.285088		1.345008		1.275666	
138 (2 2'3 4 4'5)	7.508396		13.74205		6.978972		6.935222		2.478588	
153 (2 2'4 4'5 5')	9.831612		19.085752		9.954448		11.240838		2.48962	
170 (2 2'3 3'4 4'5)	0.75509		0.500836		0.553434		0.440468		0.153538	
18 (2 2'5)	0.390264	J	0.455	U	0.364532	J	0.15169	J	0.312032	J

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ANALYTICAL RESULTS (WET WEIGHT BASIS)
FORMER ROBERT E. DEREKTOR SHIPYARD
NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND

Sample Number	DSY-40-DM		DSY-40-IBM		JPC-1-DM		JPC-1-IBM		T0-DM	
Sample Location	DSY-40		DSY-40		JPC-1		JPC-1		T-0	
Date Sampled										
Description										
Matrix	Deployed Mussel		Mussels		Deployed Mussels		Mussels		Deployed Mussel Control	
180 (2 2'3 4 4'5 5')	2.461326		2.730168		1.992634		1.77226		0.557872	
187 (2 2'3 4'5 5'6)	3.006486		6.26339		2.705934		3.518074		0.891828	
195 (2 2'3 3'4 4'5 6)	0.35014		0.39137		0.144214		0.664608		0.056	U
206 (2 2'3 3'4 4'5 5'6)	0.64582		0.490784		0.45388		0.593446		1.18293	
209 (2 2'3 3'4 4'5 5'6 6')	0.981876		0.580524		0.385028		0.363748		1.317652	
28 (2 4 4')	0.516068		1.246868		0.5621		2.409134		1.974168	
44 (2 2'3 5')	0.894656		1.111236		0.805238		0.9338		1.974014	
52 (2 2'5 5)	1.598632		1.869322		1.423366		1.767962		2.065378	
66 (2 3'4 4')	0.5397	U	0.5397	U	0.5397	U	0.5397	U	0.5397	U
8 (2 4)	0.165172	J	0.384272	J	0.382886	J	0.962346		0.329	U
PCB Sum of Congeners	38.943968		63.82208		43.163722		39.529952		20.754174	
PCB Sum of Congeners x 2	77.887936	Z	127.644174	Z	86.327444	Z	79.059904	Z	41.508348	Z
Butyltins (ng Sn/g)										
Dibutyltin	0.42	U	0.42	U	0.42	U	0.42	U	0.42	U
Monobutyltin	0.49	U	0.49	U	0.49	U	0.49	U	0.49	U
Tetrabutyltin	0.35	U	0.35	U	0.35	U	0.35	U	0.35	U
Tributyltin	0.42		4.438		1.5624		0.42	U	0.42	U
Metals (ug/g)										
Aluminum	18.5724		17.6218		33.8268		47.3466		14.0196	
Arsenic	0.8344		0.7378		0.6188		0.9478		5.047	
Cadmium	0.0854		0.0882		0.0756		0.0826		0.07	
Chromium	0.3794		0.3122		0.4074		0.3416		0.273	
Copper	0.8848		0.9786		1.0094		1.2068		1.7024	
Iron	34.3406		41.118		12.6504		42.5558		25.0348	
Lead	0.4158		0.3416		0.000042	U	0.4592		0.0861	
Manganese	1.6702		2.1532		1.3748		3.0632		0.6006	
Mercury	0.018018		0.023114		0.018802		0.02387		0.018606	
Nickel	0.4802		0.000042	U	0.4312		0.000042	U	0.000042	U
Silver	0.000014	U	0.000014	U	0.000014	U	0.000014	U	0.2044	
Zinc	16.3744		14.6846		14.9464		12.9962		12.0162	

U - Not detected; UJ - Detection limit approximate; J - Quantitation approximate;
* - From dilution analysis; R - Rejected; NA - Not Analyzed

APPENDIX E
DISCUSSIONS OF SHELLFISH CONSUMPTION RATES

Discussion on Shellfish Ingestion Rates Used

In comments to the Draft Risk Assessment Report, the RIDEM has requested that the Navy use the following average annual rates for ingestion of shellfish for calculating risk to receptors from ingestion of shellfish taken from the site:

Recreational Fishermen (Adult) - 15.6 g/day: 36.5 meals per year, 150 g. meat per meal
Recreational Fisherman (Child) - 5.0 g/day: 36.5 meals per year, 48 g. meat per meal
Subsistence Fisherman (Adult) - 80 g/day during peak months (6 months) (average annual 40 g/day)

These rates can be compared with average annual rates used for this report:

Recreational Fishermen (Adult) - 1.2 g/day: 2.9 meals per year, 150 g. meat per meal
Recreational Fisherman (Child) - 0.48 g/day: 2.9 meals per year, 48 g. meat per meal
Subsistence Fisherman (Adult) - 15.6 g/day: 36.5 meals per year, 150 g. meat per meal

The RIDEMs recommendation of 80 g/day is based on statements provided in the document "Narragansett Bay Project Current Report" NBP-92-105, Prepared by Brown et.al., Clark University, Worcester MA.(no date - document number indicates 1992). This document states that the 80 g/day is a peak month rate for evaluating reproductive and systemic risk to individuals from PCBs in quohogs. It further states "The corresponding typical peak yearly values (appropriate for estimating cancer risks) are 25% the peak monthly intake (expressed as daily intake)." Thus the Narragansett Bay Project study suggests the use of an annual average rate of 20.0 g/day, rather than the 15.6 g/day rate used in the Derecktor Shipyard HHRA or the 40 g/day rate proposed by the RIDEM.

The RIDEM also referenced a second report for consideration for shellfish ingestion rates. The FDA Center for Food Safety and Applied Nutrition evaluated ingestion of metals by humans through shellfish ingestion. The FDA study identified that out of 25,726 individuals surveyed, 4.8% ate molluscan bivalves. Of these 4.8% of the test group, average intake was determined to be 10.0 to 15.0 g/day for all individuals over age 2, 4.0 to 8.0 g/day for individuals age 2-5, and 12.0 to 18.0 g/day for individuals age 18 - 44. Thus the FDA document suggests the use of a rate between 12 and 18 g/day, which includes the 15.6 g/day rate used for Derecktor Shipyard.

These studies indicate that the ingestion rate of 15.6 g/day used in this report is valid for the evaluation of regular ingestion of shellfish from bay sources as a whole. It is the Navy's position that the industrial nature of the site, the restrictions on shellfish collection in the area, the water depth that requires a boat and dragging equipment for collection, and the large ship traffic in the area would reduce collection at the study area to result in lower ingestion rates from this source than would be derived from an entire food supply. Finally, it should be noted that the risks calculated are based on a whole series of assumptions described in Sections 5 and 7 of the report. The ingestion rate is an estimate of how much persons may actually eat from the study area, and the values should be considered only an estimate.

However, to illustrate the effect that adoption of the higher proposed rates would have on the risk estimates, a brief comparison of the calculated risks for each of the ingestion rates described above is presented below for the subsistence fisherman exposure scenario. The cancer risk calculated in this report for subsistence fisherman from the maximum concentrations of total PCBs detected in blue mussels (footnote on Table 6-4) is 3.10E-5. If the higher ingestion rates suggested were used, the risk values calculated would increase incrementally as follows:

Calculated Risk	Ing. Rate	Conversion	Revised Risk
3.10E-5	15.6 g/day [1]	1.0*risk value	3.10E-5
3.10E-5	20.0 g/day [2]	1.28*risk value	3.96E-5
3.10E-5	40.0 g/day [3]	2.56*risk value	7.94E-5
3.10E-5	80.0 g/day [4]	5.12* risk value	1.59E-4

[1] - This is the value used in this report for "subsistence fisherman"

[2] - 25% of the 80 g/day suggested by the Narragansett Bay Project

[3] - estimated from 80 g/day for peak months (6), suggested by RIDEM

[4] - assumes the 80 g/day rate is ingested all year, (2.8 ounces every day, 365 days per year) not just during the peak months as suggested by the RIDEM

All other risk values stated on Tables 6-2 through 6-13 can be multiplied by the conversion factors described above to determine the calculated risk using the corresponding ingestion rate. It is apparent from this brief comparison that even if the maximum ingestion rate described is used, the risk increase is less than one order of magnitude.

In conclusion, ingestion of shellfish taken from the study area at these higher rates is unlikely, and the rates described in Section 5 of this report are conservative and appropriate for the assessment of risks to humans from contaminants in shellfish at the Derecktor Shipyard/ Coddington Cove area.

SOURCE: USFDA, CENTER FOR FOOD SAFETY AND APPLIED NUTRITION GUIDANCE DOCUMENT FOR ARSENIC IN SHELLFISH, JANUARY, 1993

IV. CONSUMPTION AND EXPOSURE ASSESSMENT

The following sections provide estimates of chronic shellfish intake as well as estimates of arsenic exposures resulting from chronic shellfish consumption. In addition, estimates of arsenic exposure are provided for background sources, both dietary (i.e., non-seafood) and non-dietary sources.

1. Shellfish Intake

The frequency of shellfish eating occasions has been tabulated in the Market Research Corporation of America (MRCA) 14-day survey (5-Year Menu Census, 1982-87) (MRCA, 1988). The MRCA reports that only 13% of the surveyed population consumed crustaceans and only 4.8% of the surveyed population (25,726 individuals, 2+ years) consumed molluscan bivalves. Using standard portion sizes from the USDA's 3-day National Food Consumption Survey (NFCS, 1977-78) (Pao et al., 1982), we estimate the 14-day-average mean and 90th percentile daily intakes of molluscan bivalves. These are presented in Table 2. The intakes for crustacean shellfish are presented in Table 3.

Table 2. 14-Day-average intake of molluscan bivalves, grams/person/day, for eaters-only.

Age Group	Mean	90th Percentile
2+ years (all ages)	10	15
2-5 years (male/female)	4	8*
18-44 years** (male/female)	12	18

* Estimated value. Reliable data are not available in the MRCA survey. The 90th percentile value is estimated to be twice the mean (WHO, 1983).

** USDA portion size for 33-44 year age group used in the calculation. This age subgroup has the highest consumption of any subgroup in the 18-44 year range (Pao et al., 1982).

Table 3. 14-Day-average-intake of crustacean shellfish, grams/person/day, for eaters-only.

Age Group	Mean	90th Percentile
2+ years (all ages)	9	17
2-5 years (male/female)	5	10
18-44 years* (male/female)	9	19

* USDA portion size for 33-44 year age group used in the calculation. This age subgroup has the highest consumption of any subgroup in the 18-44 year range (Pao et al., 1982).

2. Arsenic Concentrations in Shellfish

The recent National Oceanic and Atmospheric Administration (NOAA) Mussel Watch project progress report (NOAA, 1989) indicates that none of the mussels or oysters in the 169 sites examined in 1988 exhibited an average total arsenic concentration in excess of 14 ppm (wet weight). This conclusion was reached by applying the following factors to convert the dry weight concentrations reported by NOAA to wet weight values: *Crassostrea virginica*, 0.124; *Mytilus edulis*, 0.121; *Mytilus californianus*, 0.140; *Ostrea sandvicensis*, 0.146 (Private Communication, 1990).

In 1985-86 the FDA surveyed the levels of arsenic in softshell clams (*Mya arenaria*), hardshell clams (*Mercenaria mercenaria*), Eastern oysters (*Crassostrea virginica*), and Pacific oysters (*C. gigas*) (S. Capar, FDA, Division of Contaminants Chemistry, unpublished data). The shellfish samples were harvested from approved waters in 20 coastal states (all coastal states except Alaska and New Hampshire). The results of that survey are presented in Table 4.

SOURCE: NARRAGANSETT BAY PROJECT CURRENT REPORT, NBP-92-105
BROWN ET. AL, CLARK UNIVERSITY, WORCESTER MA
page 7

Intermediate Assessment for PCBs and PAHs

3.0 Basis for the Intermediate Assessment

The intermediate assessment or "second decision point" in the sequence illustrated in Figure 1, is a comparison of the indices of toxicity for the different health effects found in Phase I with estimated levels of exposure based on the measured concentrations of contaminants. The goal is to provide a quick estimate of the seriousness of potential exposures to the contaminant. The appropriate indices of toxicity are shown in Table 4. As discussed in the preamble to section 2, we use indices for a generic mix of PCBs; because of the nature of the data base, PAHs, in contrast, are represented by B(a)P. From Table 4 we observe that the needed analysis for PCBs is reproductive toxicity and carcinogenesis, while for PAHs it is systemic toxicity and carcinogenesis. Typical peak levels of exposure over a one month period (appropriate for evaluating reproductive and systemic toxic effects) are .07 µg/kg-day for PCBs, and .08 µg/kg-day for the sum of identified PAHs. The calculation is made as follows: concentrations of PCBs in quahogs are .01-.06 µg/g wet weight; multiplied by 80 g/day consumption (in a peak month) and divided by a 70 kg average adult weight yields.01- .07 µg/kg-day. Peak monthly intake of B(a)P is .003 µg/kg-day. The corresponding typical peak yearly values (appropriate for estimating cancer risks) are 25% the peak monthly intake (expressed as daily intake). The calculation of cancer risks is made using the EPA defined potency index, PI as follows:] *

Cancer risk = PI x (daily intake of contaminant in clams).

3.1 Results of the Intermediate Assessment

The comparisons of exposure levels with toxicities is summarized in Table 5. The results show toxicities approaching but not exceeding typical levels of concern, and cancer risks in the range at which regulatory action is sometimes taken. As with most of the metals we discussed previously, we conclude that detailed assessments of these contaminants will be needed in the future; however, the need is not immediately urgent in that the hazards associated with these chemicals are not likely to be unmanagemable or to be the primary bar to use of the seafood resources of the Bay.